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TP 4046E

EVALUATION OF PROPANE-FUELED VEHICLES DESIGNED FOR ON-LINE PRODUCTION

by

Product Engineering Department
Chrysler Canada Ltd.
Windsor, Ontario

December 1982

for
Transport Canada
Transportation Development Centre

Un sommaire en francais de ce rapport
est inclus avant la Table des Matieres

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre of Transport Canada.

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REPORT DOCUMENTATION FORM

1. Transport Canada Report No.	2. TDC Project No.	3. Recipient's Catalogue No.
TP4046E	TDC 4294/5	

4. Title and Subtitle	5. Report Date
Evaluation of Propane-Fueled Vehicles Designed for On-Line Production	1982-12-31
	6. Performing Organization Report No.

7. Author(s)	8. Transport Canada File No.
Eric E. Durance and Brian E. Griffiths	D1465-326

9. Performing Organization Name and Address	10. DSS File No.
Chrysler Canada Ltd. P.O. Box 1621 Windsor, Ontario N9A 4H6	17ST.T8200-0-0534
	11. DSS or Transport Canada Contract No. 1ST80-00186

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Transportation Development Centre 1000 Sherbrooke Street West Suite 2421 Montreal, Quebec H3A 2R3	FINAL May 1981 - Dec. 1982
	14. Sponsoring Agency Code

15. Supplementary Notes	16. TDC Project Officer
	J.H. Morgan

17. Abstract

Fourteen prototype propane vehicles of various passenger car and light-duty truck configurations were built for evaluation of fuel consumption, driveability, performance, and convenience in a variety of fleet applications throughout Canada. The fuel consumption characteristics of these vehicles were superior to their gasoline counterparts when measured on an energy basis. Rating responses from drivers were overwhelmingly (96%) in the "satisfactory," "good," and "excellent" categories. Comments from drivers regarding "poor" ratings revealed several problems relating to cold weather operation, which were largely corrected during the program. Future design and development work needs to be directed to engine and carburetion systems, automatic shut-off fill valves, and improved low temperature operation.

Fleet owners have a keen interest in propane vehicles but are concerned that the pump prices of propane and gasoline will be allowed to converge until the economic advantage of propane disappears. Their knowledge of the motor fuel and safety characteristics of propane and the current propane distribution system is very restricted. These factors are limiting sales, which are currently below the level required to achieve the substantial cost savings available from efficiently integrating propane systems into assembly plants.

Propane utilization in the transportation segment may fall short of objectives if incentives continue to be directed solely at commercial applications. An increasing proportion of commercial sales is expected to go to diesel vehicles, which have a compelling fuel efficiency advantage in urban service. To offset the effect of this trend, government incentives should be extended to private buyers of contemporary lightweight propane vehicles that meet prescribed high efficiency standards. While the annual fuel consumption of individual vehicles of this type is not high, the proportion of energy that can be conserved with propane in typical private-use patterns is likely greater than for any other application. Incentives geared to efficiency criteria would avoid the perpetuation of needlessly large inefficient vehicles in private service.

18. Key Words	19. Distribution Statement
propane, vehicles, fuel consumption, driveability, automotive production methods, sales forecast	Limited number of copies available from sponsoring agency

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No. of Pages	23. Price
Unclassified	Unclassified	97	NIL

TDC CDT 79-005

FORMULE DE DOCUMENTATION POUR RAPPORT

1. N° du rapport Transports Canada	2. N° de l'étude — CDT	3. N° de catalogue du destinataire
TP4046E	TDC 4294/5	

4. Titre et sous-titre	5. Date du rapport
Evaluation of Propane-Fueled Vehicles Designed for On-Line Production	1982-12-31
	6. N° du rapport de l'organisme exécutant
7. Auteur(s)	8. N° de dossier Transports Canada
Eric E. Durance and Brian E. Griffiths	D1465-326
9. Nom et adresse de l'organisme exécutant Chrysler Canada Ltée. P.O. Box 1621 Windsor, Ontario N9A 4H6	10. N° de dossier — ASC 17ST.T8200-0-0534
	11. N° de contrat — ASC ou Transports Canada 1ST80-00186
12. Nom et adresse de l'organisme parrain Centre de développement des transports 1000 Sherbrooke Quest Suite 2421 Montréal, Québec H3A 2R3	13. Genre de rapport et période visée FINAL mai 1981 - déc. 1982
	14. Code de l'organisme parrain
15. Remarques additionnelles	16. Agent de projet — CDT J.H. Morgan

17. Résumé

Quatorze prototypes de véhicules au propane, aussi bien des voitures privées que des utilitaires légers, ont été construits pour que soient évaluées leurs diverses caractéristiques: consommation, conduite, performances et utilité. Ils ont pour cela été mis à la disposition de propriétaires de parcs, un peu partout au Canada. Le rapport montre que, comparativement aux véhicules à essence, les véhicules de démonstration ont eu un rendement énergétique moyen plus élevé. Quant aux conducteurs de ces véhicules, dans la très grande majorité (96%), ils leur ont donné la cote: satisfaisant, bon ou excellent. Les autres ont mis en évidence plusieurs faiblesses liées au fonctionnement par temps froid, mais qui ont été pour la plupart corrigées en cours de programme. Les domaines nécessitant des perfectionnements sont la carburation, les soupages d'arrêt automatique de remplissage et le fonctionnement par temps froid.

Le rapport affirme qu'il existe chez les propriétaires de parcs un grand intérêt pour le moteur au propane, mais qu'ils craignent que les prix à la pompe du propane et de l'essence aillent en se rapprochant de plus en plus, jusqu'à la disparition complète de l'avantage financier du propane. Ils disent savoir peu de choses sur le propane; ses propriétés, la sécurité de son utilisation et le réseau de distribution. Ces facteurs ont inhibé les ventes qui restent en deçà du niveau requis pour réaliser les importantes économies découlant d'une intégration harmonieuse des véhicules au propane dans le schéma des fabrications normales.

La conversion au propane des véhicules de transport routier risque de ne pas atteindre les objectifs fixés si les mesures incitatives continuent à ne s'adresser qu'aux véhicules commerciaux. La part du marché occupée par les véhicules diesel semble devoir aller en croissant étant donné leur rendement énergétique difficile à égaler en service commercial urbain. Pour faire contrepoids, les mesures incitatives adoptées par le gouvernement devraient être étendues aux particuliers désireux d'acheter des véhicules au propane légers et économiques, satisfaisant à des normes de rendement élevé. Même si la consommation annuelle par cette catégorie de véhicules n'est pas élevée, il reste que c'est la conversion au propane du parc des voitures privées qui permettrait de réaliser la plus grande économie d'énergie. Ces mesures incitatives couplées à des normes de rendement permettraient de mettre un terme à l'ère des grosses voitures privées inefficaces.

18. Mots-clés	19. Diffusion
Propane. Véhicules routiers. Consommation de carburant. Conduite, Fabrication série. Prévisions de vente.	Le CDT dispose d'un nombre limité d'exemplaires.

20. Classification de sécurité (de ce rapport)	21. Classification de sécurité (de cette page)	22. Nombre de pages	23. Prix
Non-classifié	Non-classifiée	97	NIL

CDT TDC 79-005

SUMMARY

This report presents the activities and results of a design and development program under the direction of the Transportation Development Centre of Transport Canada relating to the popularization and evaluation of factory-built propane vehicles for light vehicle fleet application. The main objectives of the program were to:

- place demonstration propane-fueled vehicles with a variety of fleet owners across Canada for them to evaluate for their own applications.

- acquire development and manufacturing experience and cost information toward eventual on-line assembly of propane vehicles.

- monitor vehicles in demonstration service for fuel consumption, performance, driveability, and overall customer acceptability.

- assess future market potential.

- assess future design and development needs.

To achieve these objectives, Chrysler Canada Ltd. built fourteen prototype, propane vehicles. Over a fifteen-month timeframe they were located with commercial fleets across Canada for short periods for evaluation. Driver rating and comment questionnaires as well as fuel consumption records were returned to Chrysler Canada Ltd. for analysis and compilation.

The experience and information gained from developing, manufacturing, and demonstrating these vehicles have led to the following conclusions and recommendations:

- A keen interest in propane vehicles exists among fleet owners that is not yet reflected in new vehicle purchases.

- Ratings by the drivers of the vehicles were predominately (96%) "satisfactory" to "excellent." Comments from drivers regarding "poor" ratings pointed out several problems, mainly relating to cold weather operation, which in most cases were corrected or alleviated during the program.

- These demonstration propane vehicles are considered representative of the present level of development.

When compared to their gasoline counterparts, the average energy consumption ratios for all vehicle types were determined to be .86 (14% better) on the city cycle and .91 (9% better) on the highway cycle, using the Transport Canada dynamometer test procedure. These test results were supported by fuel consumption data reported by users of the vehicles which indicated an average "in-use" energy consumption ratio of .85 (15% better).

- The advantages of propane vehicles over gasoline vehicles tend to increase at low engine temperatures. The fuel efficiency advantage is enhanced because there is no choke cycle, and the fast idle is slower and ends sooner. Absence of manifold vaporization and distribution difficulties of the conventional gasoline engine at low temperatures results in superior driveability and less degradation in emissions. Propane vehicles, therefore, are better suited to short trips under Canadian winter conditions than are gasoline vehicles.

- It is clear from our marketing analysis that continuing government supportive actions are required to attain propane motor fuel use goals.

- Approximate sales volumes (per vehicle type) of 1500 units per year or run batches of 350 or more vehicles at a time would permit higher levels of on-line assembly with substantial cost savings.

- Propane vehicles may have limited long-range potential for use in urban commercial service which involves long periods of operation in stop-and-go traffic. Diesel vehicles have dramatically lower fuel costs in this type of service and it is unlikely that changes in the relative prices of fuels will be great enough to eliminate this advantage. Reasonably priced diesel vehicles are becoming increasingly available for these applications.

- Federal government incentives should therefore be extended to private owners who purchase lightweight, fuel-efficient, propane vehicles. This selective broadening of incentives would take additional vehicles off gasoline without creating an undesirable incentive for continued use of large private vehicles. The cost recovery period for the propane option on larger vehicles is already relatively short because of their greater fuel throughput.

- High priority should be given to improving the design of components that affect the starting and operating characteristics of propane vehicles in cold weather. Additional design and development work needs to be directed to the following areas: engine efficiency and durability, 80% automatic shut-off valves, unconventional tank shapes, modularization of components, and assembly plant process studies to integrate propane systems into regular assembly plant procedures.

There are related technical and consumer-attitude factors that are inhibiting the faster expansion of the propane vehicle fleet. Poorly designed or low-cost propane vehicle fuel systems and installations have resulted in serious driveability, performance, fuel consumption, and durability problems which have caused costly down-time, warranty disputes, and even retrofitting to gasoline. Our contacts with buyers over the past year have provided some insight into negative consumer attitudes toward propane and propane vehicles that can be summarized as follows:

- There is a widespread concern among fleet operators that the pump prices of propane and gasoline will be allowed to converge until there is no longer a fuel cost advantage to offset the inconveniences of operating on propane.

- Propane's excellent properties as a motor fuel are not widely known.

- Knowledge of the expanding Canadian automotive propane distribution network is almost non-existent.

- Propane fuel is generally thought to be inherently less safe than gasoline.

The work to be done notwithstanding, these demonstration vehicles were well received in the field, generated a large number of positive comments, and have had a significant impact on Canadian fleet operator awareness of propane and propane vehicles and of government and industry efforts to popularize their use. The building and demonstration of these prototype vehicles have also provided Chrysler Canada Ltd. with important development and marketing experience and information that is already being usefully applied to current propane vehicle production programs.

SOMMAIRE

Ce rapport rend compte des travaux, ainsi que du résultat, d'un programme d'étude et de perfectionnement parrainé par le Centre de développement des transports, Transports Canada et visant à favoriser la percée des véhicules au propane sur le marché des utilitaires légers. Les principaux objectifs de ce programme ont été les suivants:

- mettre à la disposition des propriétaires de parcs un peu partout au Canada, des véhicules au propane pour qu'ils puissent en faire l'évaluation dans les conditions d'exploitation propres à leur entreprise;

- acquérir de l'expérience dans le domaine du perfectionnement et de la fabrication de ces véhicules, ainsi que des données chiffrées permettant d'établir les prix de revient des fabrications en série;

- connaître les performances de ces véhicules en service expérimental: consommation, rendement, conduite, ainsi que l'opinion de l'utilisateur;

- faire une étude des débouchés éventuels;

- définir les besoins futurs en matière de conception et de perfectionnement.

Dans ce but, Chrysler Canada a construit quatorze prototypes qui, au cours d'une période de 15 mois, ont été confiés à tour de rôle à diverses entreprises exploitant un parc de véhicules commerciaux, un peu partout au Canada. Ces dernières ont fourni à Chrysler de précieux renseignements sur les divers paramètres de fonctionnement, et lui ont transmis l'opinion et les remarques de ceux qui ont conduit les véhicules, renseignements que Chrysler a compilés et analysés.

Les conclusions tirées du programme de perfectionnement, de fabrication et de démonstration, et les recommandations qui en découlent, sont les suivantes:

- Il existe chez les propriétaires de parcs un grand intérêt pour les véhicules au propane, lequel ne s'est pourtant pas encore traduit par des achats.

- La très grande majorité des conducteurs (96%) ont attribué à ces véhicules une cote qui va de "satisfaisant" à "excellent." Les autres ont mis en évidence plusieurs faiblesses liées au fonctionnement par temps froid, qui ont été pour la plupart corrigées ou atténuées en cours de programme.

- La plus haute priorité doit être donnée à l'amélioration des départs et du fonctionnement par temps froid. Les autres points à perfectionner ou à étudier sont: le rendement, la durée de vie utile, la soupape d'arrêt automatique de remplissage à 80% de la capacité du réservoir, la forme des réservoirs, la conception de composants modulaires et un plan de fabrication série s'intégrant dans le schéma des fabrications normales.

Si le moteur au propane n'a pas connu l'essor qu'on lui prédisait, c'est pour des raisons à la fois techniques et psychologiques. Du côté technique, citons les systèmes et composants mal conçus ou bon marché qui ont sérieusement entravé les qualités du moteur: souplesse, performances, consommation et durée de vie, causant d'onéreuses indisponsibilités, des litiges autour de la garantie et même le retour de certains à l'essence. Quant à l'aspect psychologique, nos contacts avec les acheteurs au cours de l'année écoulée nous ont permis de mettre le doigt sur les raisons du malaise éprouvé par le consommateur à l'égard du moteur au propane. Ces raisons se résument comme suit:

- L'impression assez généralement répandue parmi les propriétaires de parcs que les prix à la pompe du propane et de l'essence se rapprocheraient de plus en plus jusqu'à la disparition complète de l'avantage financier du propane et qui compensait ses inconvénients.

- Les propriétés avantageuses du propane comme carburant ne sont pas largement connues.

- L'ignorance totale du développement que connaît le réseau de distribution du propane comme carburant pour les véhicules routiers au Canada.

- L'idée généralisée que le propane est d'utilisation moins sûre que l'essence.

Exception faite de ces quelques lacunes, il reste que les véhicules de démonstration ont été bien accueillis, ont laissé une très bonne impression et ont permis aux propriétaires de parcs de prendre conscience de l'existence du moteur au propane et des efforts concertés du gouvernement et de l'industrie en faveur du propane. Pour sa part, Chrysler Canada a, grâce au programme de fabrication et de démonstration, acquis une solide expérience dans ce secteur, qui bénéficie d'ores et déjà aux programmes visant la production de ce type de véhicules.

- Les véhicules expérimentaux représentent l'état actuel des connaissances en la matière. Il a été déterminé que la consommation énergétique moyenne des véhicules au propane s'établissait à 86% de celle des véhicules à essence, pour un gain de 14%, en circulation urbaine, et à 91% pour un gain de 9% en circulation autoroutière. Ces résultats ont été obtenus par des essais dynamométriques suivant la méthode préconisée par Transports Canada et ont été confirmés par les utilisateurs eux-mêmes qui, dans l'ensemble, ont dégagé un gain de consommation moyen de 15%.

- L'avantage du moteur au propane sur le moteur à essence est plus évident dans les départs à froid pour les raisons suivantes: absence de marche en régime enrichi, et ralenti accéléré plus lent et se terminant plus tôt. En outre, le moteur au propane ne présente pas les problèmes de vaporisation et de distribution inhérents au moteur à essence surtout par temps froid, ce qui en fait un moteur plus souple et moins polluant. L'avantage revient donc au premier pour les déplacements courts dans les conditions hivernales du Canada.

- L'étude de marché a montré que l'appui soutenu du gouvernement est nécessaire pour que les objectifs du programme de conversion au propane puissent se réaliser.

- Il faut que la quantité de véhicules vendus atteigne le chiffre de 1 500 par catégorie et par an, ou bien qu'on puisse procéder à la fabrication par lots de 350 véhicules au moins, pour que les économies réalisables puissent être intéressantes.

- En service commercial urbain, avec ses nombreuses séquences de marche-arrêt, l'utilité à long terme du moteur au propane est plutôt mince. Surtout par rapport au moteur diesel dont le rendement énergétique dans le même contexte est difficile à égaler. Il est peu probable que l'écart entre les prix de ces deux carburants demeure assez élevé pour annuler l'avantage du diesel qui occupe, d'ailleurs, une part de plus en plus grande du marché, à un prix de plus en plus concurrentiel.

- Les mesures incitatives adoptées par le gouvernement fédéral devraient être étendues aux particuliers désireux d'acheter des véhicules au propane, légers et économiques. Il s'agit de les détourner des véhicules à essence, mais sans favoriser le retour aux grosses cylindrées d'avant la crise du pétrole. On sait que la période de récupération du surcoût d'une grosse voiture au propane est déjà relativement courte, étant donné les grandes quantités de carburant que cette catégorie de voitures consomme.

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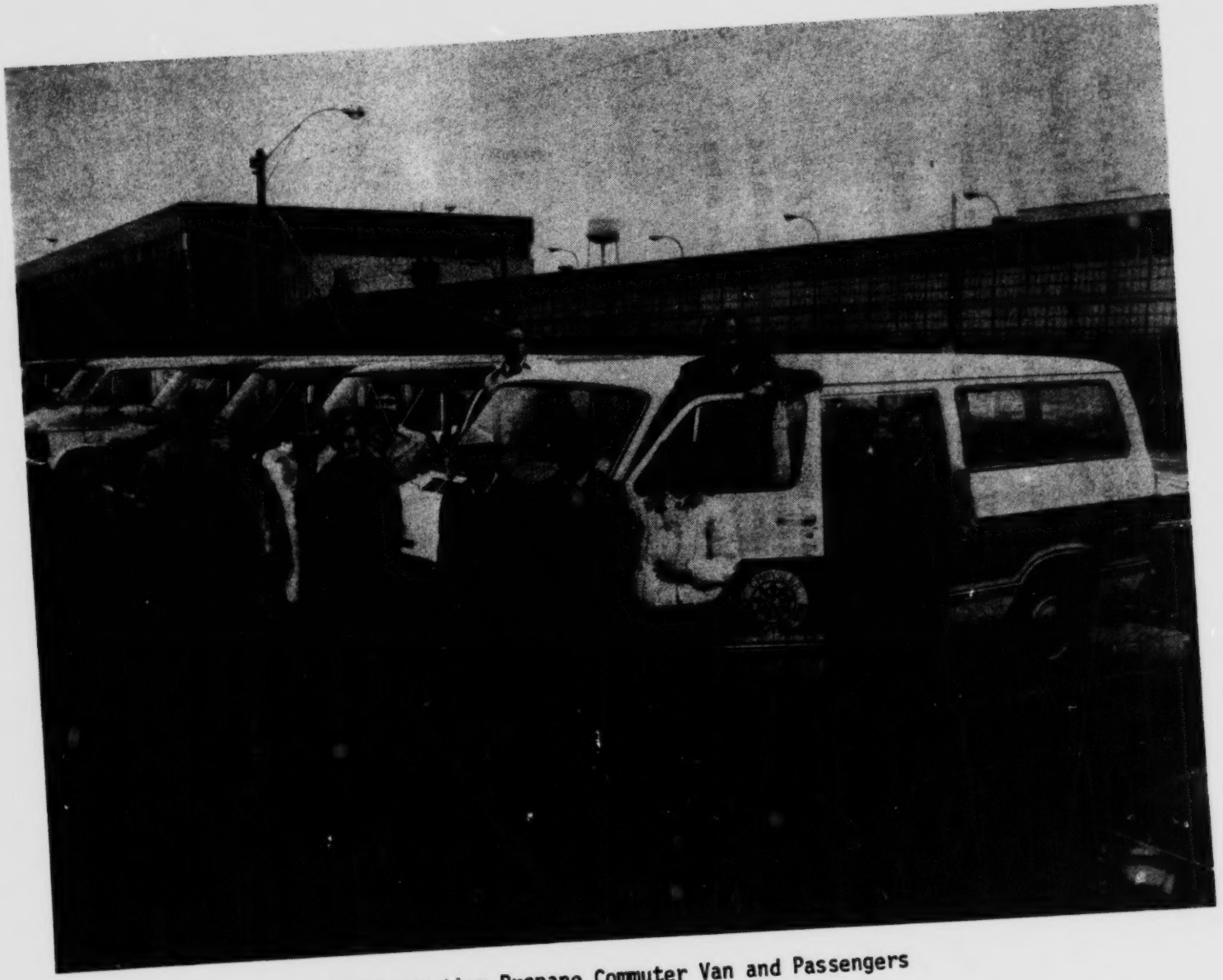

Demonstration Propane Commuter Van and Passengers

1. INTRODUCTION

Propane is available in Canada in large enough quantities to fuel a significant portion of the current motor vehicle fleet. Achieving this level of propane utilization will be dependent on the availability and popularity of a variety of factory-built propane vehicles with minimum acquisition cost differentials over comparable gasoline units. Aftermarket conversions are wasteful. Cost factors limit the extent to which a conversion shop can alter a vehicle. There is a growing awareness that converted gasoline engines usually have shortened lives because critical internal engine parts were not changed to offset the severe wear conditions imposed by propane. Similarly, fuel is wasted because converters cannot afford to make as many efficiency-related changes as can be justified at the time of vehicle manufacture.

This report describes the activities and results of a design and development program relating to the popularization and evaluation of factory-built propane vehicles. Fourteen prototype vehicles were built by Chrysler Canada Ltd. Over a fifteen-month timeframe they were assigned to commercial fleet operators across Canada for short periods. The main objectives of the program were to:

- place demonstration propane vehicles with a variety of fleet owners across Canada for them to evaluate for their own applications.

- acquire development and manufacturing experience and cost information toward eventual on-line assembly of propane vehicles.

- monitor vehicles in demonstration service for fuel consumption, performance, driveability, and overall customer acceptability.

- assess future market potential.

- assess future design and development needs.

During the course of the program, monthly and quarterly reports containing substantive information on the results of the work were submitted to the Transport Canada Transportation Development Centre. Much of that material (updated as required) is also contained in this final report.

2. PROGRAM MANAGEMENT

The contract for this program resulted from an unsolicited proposal by Chrysler Canada Ltd. to the Science Procurement Centre of the Department of Supply and Services. Chrysler Canada Ltd. Product Engineering agreed to carry out the program under the overall direction of the Transportation Development Centre of Transport Canada beginning March 1, 1981 with completion December 31, 1982.

A Work Plan and Scheduled Activities approved by the Transportation Development Centre were submitted on March 30, 1981 (see Appendix A). Manpower and material records and costs were maintained by Chrysler Canada Ltd. throughout the program.

Regular progress reports (7 quarterly and 9 monthly) were submitted to the Transportation Development Centre during the program. These reports contained information on status of work, adherence to schedules, and results of work done.

3. DESIGN SPECIFICATIONS AND FABRICATION OF PROPANE DEMONSTRATION VEHICLES

Chrysler Canada Ltd. built fourteen popular fleet account vehicles with major specifications as shown in Table 1. Other than the special requirements for propane operation, the vehicles were the same as gasoline vehicles.

3.1 Engine, Ignition, and Carburetion Systems

Propane is stored in the vehicle's fuel tank as a liquid under a pressure of 863 kPa at an ambient temperature of 21°C. Since it is under pressure, no fuel pump is required to supply it to the vaporizer where it is converted to vapour and then to the carburetor where it is mixed with air and distributed through the intake manifold to the engine's combustion chambers.

Propane fuel enters the intake manifold as a gas and does not require the intake manifold heating needed by gasoline engines to aid fuel vaporization. Manifold heating must therefore be blocked in propane engines to prevent reduction in density of the intake fuel charge which would be detrimental to engine performance.

The different ignition delay and flame speed properties of propane fuel affect ignition timing requirements. Also since propane undergoes more complete combustion than gasoline, it is cleaner burning and does not require the same emission-related constraints on ignition timing as gasoline.

For operation on propane, the regular gasoline engine, ignition, and carburetion systems required modifications.

3.1.1 5.2 L Engine, Ignition, and Carburetion System Modifications

- Engine: The exhaust heat control valve was removed and an intake manifold gasket with one closed section installed to block off the hot exhaust gases from the intake manifold. The top piston ring was changed from chrome-plated to tin-plated, to assist break-in seating of the rings. Although not done for these prototype vehicles, we are now using high-alloy valve seat inserts in our current production 5.2 L propane engine.

VEHICLE TYPE	LAST 3 DIGITS OF VIN	ENGINE DISPL/CYL	TRANS	PLACED IN SERVICE	REMOVED FROM SERVICE	DEMONSTRATION CENTRE
COMMUTER VANS	274	5.2 L/8 CYL	AUTO	81-08-07	82-08-31	WINDSOR
	275	5.2 L/8 CYL	AUTO	81-08-07	82-08-31	WINDSOR
	276	5.2 L/8 CYL	AUTO	81-08-07	82-08-31	WINDSOR
PANEL VANS	422	3.7 L/6 CYL	MAN	81-10-01	82-09-30	MONTREAL
	443	3.7 L/6 CYL	AUTO	81-10-01	82-09-30	TORONTO
	584	5.2 L/8 CYL	AUTO	81-10-01	82-09-30	EDMONTON
PICK-UP TRUCKS	679	3.7 L/6 CYL	MAN	81-10-03	82-09-01	TORONTO
	131	3.7 L/6 CYL	AUTO	81-10-01	82-09-30	MONTREAL
	097	5.2 L/8 CYL	AUTO	81-10-08	82-08-30	EDMONTON
CONVENTIONAL TAXIS	219	3.7 L/6 CYL	AUTO	81-07-01	82-08-30	TORONTO
	486	3.7 L/6 CYL	AUTO	81-07-01	82-08-30	MONTREAL
	485	5.2 L/8 CYL	AUTO	81-07-01	82-08-31	EDMONTON
FRONT WHEEL DRIVE CARS	416	2.2 L/4 CYL	AUTO	81-12-01	82-09-30	WINDSOR
	415	2.2 L/4 CYL	MAN	81-12-01	82-09-30	WINDSOR

1982-10-30

TABLE 1 PROPANE DEMONSTRATION VEHICLE SPECIFICATION AND SERVICE RECORD

- Ignition: A dual-pickup distributor was installed to avoid compromises between the high basic timing needed for efficient operation at idle (18°BTC) and the less advanced timing essential for reliable cold weather starting (10°BTC). The distributors also had special centrifugal and vacuum controls tailored for fuel consumption and performance using the best information then available.

- Carburetion: Impco model CA225 carburetor, model E vaporizer, and VFF30 fuel shut-off were installed in place of the regular gasoline carburetor and fuel pump. Development testing by Chrysler Canada Ltd. for fuel consumption and driveability determined the need to modify the vaporizer to lean out the air fuel mixture under cruise driving conditions. A start-assist valve to prime the engine for good cold starting was also developed. These changes were incorporated before the vehicles were assigned for fleet demonstrations. Subsequent development work provided a throttle-operated cut-out switch to override the priming function should a flooding condition occur. A two-speed idle system controlled by engine block coolant temperature was also developed to allow use of a fast idle speed for stable cold engine start-up and a slower warmed-up idle speed for overall efficient operation.

3.1.2 3.7 L Engine, Ignition, and Carburetion System Modifications

- Engine: The exhaust heat control valve was removed and a solid intake manifold gasket was installed to block off the hot exhaust gases from the intake manifold.

- Ignition: A dual-pickup distributor was installed for the same reasons stated in section 3.1.1 for the 5.2 L engine.

- Carburetion: Impco model CA125 carburetor, model E high capacity vaporizer, and VFF30 fuel shut-off were installed in place of the regular gasoline fuel components. As a result of further development work and testing, changes were made to the vaporizer to lean out the air fuel mixture under cruise conditions and a start-assist valve was added for engine priming. Later in the program a throttle-operated cut-out switch to override the priming function if flooding occurs was developed as well as a coolant-controlled, two-speed idle system.

3.1.3 2.2 L Engine, Ignition, and Carburetion System Modifications

- Engine: The engine coolant flow to the intake manifold was removed to prevent heating of the manifold. The gasoline version of this engine has low alloy, sintered, valve seat inserts with similar wear properties to induction-hardened cast iron seats.

- Ignition: A special spark control computer with a timing schedule tailored for fuel consumption and performance was installed. The computer also incorporated the different start and run timing feature.

- Carburetion: Impco model CA100 propane carburetor, model J vaporizer, and VFF30 fuel shut-off were installed in place of the regular gasoline components. A start-assist valve for priming with a throttle-operated cut-out switch and a two-speed idle system controlled by engine block coolant temperature were developed and installed.

3.2 Fuel Systems

Fuel tank installations were custom designed for each of the vehicle body types. They were sized to provide driving range equal to or greater than that of the vehicle's gasoline counterpart.

3.2.1 Fuel Tanks

The fuel tanks were two cylindrical units manifolded to provide a good combination of tank capacity, ground clearance and, in the case of passenger cars, minimum intrusion into the cargo space. A revised single fuel tank installation was developed later in the program to provide greater trunk space without loss of fuel capacity on the conventional taxis. In all cases the tanks were located outside the passenger or cargo compartments of the vehicles. The tanks were equipped with integral mounting brackets which bolted directly to the vehicle structure for strong, reliable installations. Integral with the tanks was a fuel level-sensing float which was magnetically coupled to a variable-resistance transducer that controlled the vehicle's standard fuel gauge. All tanks were designed and manufactured in accordance with the requirements of the ASME Standard for Pressure Vessels. They were designed for a working pressure of 1724 kPa and were equipped with 80% fixed liquid level probes and with double backcheck, pressure relief, and excess flow valves in conformance with current standards.

3.2.2 Fuel Level Indicators, Fuel Fillers, and Fuel Lines

The fuel filler system was designed to locate the fill valve in the standard gasoline fill location. The fuel level transducer and float system were designed to operate the standard instrument-panel-mounted gasoline gauge. Approved fittings and steel fuel lines connected the fuel tank to a hydrostatic pressure relief valve and to the fuel shut-off and filter.

3.3 Vehicle Driveability Evaluations

Each vehicle was evaluated by engineering personnel for driveability in conformance with Chrysler Canada Ltd. Vehicle Driveability Evaluation Procedure (see Appendix B) to assure their acceptability for the demonstration phase of the program. Original evaluations were done in Windsor at relatively warm ambient temperatures. Subsequent cold-weather driveability evaluations were done in Kapuskasing and Timmins on two of the vehicles (#416 and #486). The results which are very good to excellent are shown in Table 2.

VEHICLE NO.	COLD START	COLD IDLE	COLD DRIVE	HOT START	HOT IDLE	HOT DRIVE	FULLY WARMED-UP IDLE	FULLY WARMED-UP DRIVE	FULLY WARMED-UP PERFORMANCE
131 Temp. 9°C Rel. Hum. 81%	8	8	8	9	7	8	7	8	8
486 Temp. 23°C Rel. Hum. 78%	6	6	8	9	7	9	6	9	6
485 Temp. 22°C Rel. Hum. 83%	6	7	9	9	7	9	7	9	7
274 Temp. 24°C Rel. Hum. 78%	4	8	8	8	8	8	9	8	8
275 Temp. 24°C Rel. Hum. 78%	7	8	8	7	8	8	8	8	7
276 Temp. 24°C Rel. Hum. 78%	5	7	8	7	7	7	8	7	7
416 Temp. 9°C Rel. Hum. 76%	7	7	7	9	8	8	7	8	8
415 Temp. 4°C Rel. Hum. 65%	7	7	8	9	7	8	7	8	8
679 Temp. 9°C Rel. Hum. 75%	7	7	7	9	7	7	7	7	7
584 Temp. 13°C Rel. Hum. 90%	8	7	8	6	7	8	7	8	8
422 Temp. 11°C Rel. Hum. 87%	2	7	8	8	7	8	7	7	8
443 Temp. 10°C Rel. Hum. 71%	8	7	8	9	7	8	7	8	8
097 Temp. 18°C Rel. Hum. 88%	6	7	8	9	7	8	7	8	8

TABLE 2 DRIVEABILITY EVALUATION RATINGS FOR PROPANE VEHICLES

VEHICLE NO.	COLD START	COLD IDLE	COLD DRIVE	HOT START	HOT IDLE	HOT DRIVE	FULLY WARMED-UP IDLE	FULLY WARMED-UP DRIVE	FULLY WARMED-UP PERFORMANCE
486 Temp. 0°C Rel. Hum. 80%	9	8	8	8	8	8	8	9	8
Temp. -15°C	9	8	8	8	8	8	8	9	8
Temp. -30°C	9	7	7	7	8	8	8	9	8
Temp. -40°C	8+	8	8	8	8	7	8	8	8
416 Temp. 0°C	8	8	8	8	8	8	8	8	8
Temp. -15°C	8	7	8	7	7	7	7	8	8
Temp. -30°C	7#	7#	7	8	7	8	8	7	8
Temp. -40°C	7#	7#	7	8	7	8	7	8	8

+ vehicle needed engine block heater to overcome cold soak oil friction at this temperature (engine would not crank)

vehicle needed engine block heater to start and cold idle at these temperatures

TABLE 2 - (continued)

4. FIELD DEMONSTRATION OF THE VEHICLES AND RESULTS

4.1 General

The main purpose of the demonstration phase of the program which extended over fifteen months was to provide fleet operators with one or more propane vehicles which they could use in their normal business activities for a long enough period of time to evaluate for their own applications. They were requested to provide information to Chrysler Canada Ltd. on performance, driveability, and fuel consumption by completing driver questionnaires and maintaining fuel consumption record books. The Test Plan for demonstration of the vehicles is shown in Appendix C. The distribution of vehicles to demonstration centres across Canada is shown in Table 1.

4.2 Vehicle Location Record

A panel van, pickup truck, and conventional taxi were sent to each of the Toronto, Montreal, and Edmonton-Calgary market areas where they were scheduled by the regional coordinators for short periods with fleet accounts. Chrysler Canada Ltd. assigned three additional non-program propane vehicles to the Vancouver, Winnipeg and Moncton-Halifax areas for similar demonstration use. In all, the vehicles were located with one hundred and thirty-four fleets. In some cases they were with one company or government body for extended periods while being circulated to several branch offices or government departments. Driver questionnaires and fuel consumption records for these vehicles were returned to Product Engineering by the regional coordinators. The three taxis were evaluated by DND in Ottawa for about a month prior to being sent to the regions. The three commuter vans were located with the Chrysler Canada Ltd. commuter van fleet and were driven over the same routes during the entire period. These routes were selected to provide a varied combination of city/highway driving. Fuel consumption records and driver questionnaires were completed consistently and reported weekly for these vehicles. The two front-wheel-drive cars were located with the Product Engineering Department for a cold-weather trip and continuing development of components except for a short period when they were assigned to two local couriers for fast metrage accumulation to obtain information on performance and in-use fuel consumption, and a preliminary indication of engine durability. The extended engineering time on these two vehicles was used to address development problems unique to the four-cylinder engines. The complete vehicle location record is shown in Appendix D.

4.3 CVS Fuel Consumption and Emission Tests

The amended contract specified eighteen fuel consumption and emission tests to be performed in accordance with the test methods specified by Transport Canada. The test vehicles were selected in order to provide test data to use with other available inputs for comparing the as-tested fuel consumption of the propane vehicles with gasoline vehicles having similar specifications. The results of the testing are shown in Table 3 and comparisons are made with gasoline vehicles in section 4.4. Because of the continuing work being carried out during the program to develop vehicles with better than acceptable fuel consumption ratings, twenty-eight tests were performed. The additional ten tests were not charged for.

4.4 As-Tested Propane/Indolene Vehicle Fuel Consumption Comparisons and Energy Consumption Ratios

The fuel consumption test results in Table 3 of section 4.3 were used with other test results of gasoline vehicles to provide a comparison between propane vehicles and gasoline vehicles with similar specifications on an energy consumption basis (see Table 4). To determine the vehicle energy consumption ratios (VECR) for the propane vehicles compared to their gasoline counterparts, a lower heating value ratio (.71) of propane/indolene was used to take into account the different lower heating values of the two fuels. Definition and calculation of this ratio are shown in Appendix E. The average VECR for all the vehicles listed in Table 4 is .86 (city) and .91 (hwy). Since a VECR of less than 1 represents a favourable energy consumption ratio for the propane vehicle it is evident that even at today's level of vehicle development an overall energy use reduction can be expected from factory-built propane vehicles.

4.5 In-Use Propane/Gasoline Vehicle Fuel Consumption Comparisons and Energy Consumption Ratios

Returned fuel consumption records for the vehicles were analysed to calculate their actual in-use fuel consumption. These results were compared to the actual fuel consumption for similar gasoline vehicles in Table 5 and vehicle energy consumption ratios were calculated. To take into account the difference in lower heating values of indolene and the range of regular leaded gasoline available at service stations, a different ratio was used (.75 typical, see appendix E).

VEH. NO.	TEST NO	TEST DATE	METRAGE	GRAMS/MILE HC	CO	NOx	L/(100km) CITY	HIGHWAY	COMMENTS
PROPANE VEHICLES									
6 CYL MAN TRANS PICKUP									
679	0596	81-09-17	124	3.618	2.33	3.990	22.10	13.32	
6 CYL AUTO TRANS PICKUP									
131	0926	81-10-16	258	1.865	7.57	11.807	20.10	16.97	
8 CYL AUTO TRANS PICKUP									
097	0242	81-08-14	432	1.710	10.39	7.309	23.37	20.10	CREW CAB
6 CYL MAN TRANS VAN									
422	0586	81-09-17	346	2.028	4.01	7.934	16.93	14.78	
6 CYL AUTO TRANS VAN									
443	0597	81-09-17	1034	1.762	17.42	10.841	18.04	15.30	
443	2535	82-03-17	9772	1.470	8.89	9.857	17.26	14.49	HIGH METRAGE TEST
8 CYL AUTO TRANS VAN									
584	0637	81-09-22	438	1.360	15.28	6.705	20.75	15.83	
584	4079	82-08-09	6600	1.526	10.77	6.742	19.88	15.72	HIGH METRAGE TEST
6 CYL AUTO TRANS TAXI									
219	9563	81-06-22	228	2.511	71.81	3.142	19.73	13.60	
486	9603	81-06-24	117	2.771	49.79	4.505	18.81	14.40	
486	9604	81-06-26	178	1.719	51.96	4.066	18.91	14.17	REPEAT TEST
486	0147	81-08-06	-	1.397	11.36	7.675	16.36	12.60	BALANCE LINE ADDED
486	0241	81-08-14	3420	1.272	4.94	9.704	15.57	11.87	EC1 COVER ADDED
486	0369	81-08-27	4739	1.524	8.15	10.224	16.25	12.27	LEAN MIXTURE VALVE ADDED
486	0393	81-09-01	4841	1.487	19.58	8.013	17.13	13.06	EC1 COVER REMOVED
486	1644	81-12-23	8600	1.272	6.01	8.267	15.02	11.44	HIGH METRAGE TEST WITH EC1 COVER ADDED & LEAN MIXTURE VALVE REMOVED
8 CYL AUTO TRANS TAXI									
485	9564	81-06-23	222	1.198	11.75	5.365	19.42	14.21	
485	9574	81-06-24	284	1.199	11.55	5.890	19.85	14.63	REPEAT TEST
485	0362	81-08-27	3329	0.947	2.76	4.067	18.67	12.54	NEW TEST WITH EC1 COVER AND 2.4:1 A/R
4 CYL MAN TRANS FWD CAR									
415	1397	81-11-30	254	1.256	3.88	3.959	11.90	7.95	
415	3373	82-06 02	9462	1.747	24.63	1.075	11.80	8.39	HIGH METRAGE TEST WITH REV'D VAP & CARB (LATEST PROD'N HARDWARE)
4 CYL AUTO TRANS FWD CAR									
416	1383	81-11-24	424	0.825	18.74	4.490	13.32	9.76	
416	1409	81-12-02	444	0.986	38.00	2.481	13.41	10.31	REV'D VAP & CARB TO IMPROVE DRIVEABILIY
416	3148	82-05-07	6907	0.944	2.82	3.756	12.12	9.67	HIGH METRAGE TEST WITH IMPROVED CARB & VAP (LATEST PROD'N HARDWARE)
GASOLINE VEHICLES									
6 CYL AUTO TRANS VAN									
574	2777	82-03-31	100	1.374	25.63	1.600	15.02	12.50	
574	3331	82-05-26	7624	1.306	24.71	2.016	13.43	11.83	HIGH METRAGE TEST
8 CYL AUTO TRANS VAN									
575	2756	82-03-30	117	2.366	28.10	3.167	18.09	12.49	
575	3245	82-05-17	6373	2.422	22.94	3.278	17.16	12.31	HIGH METRAGE TEST

NOTES: CARBON BALANCE CORRECTION FACTOR OF .6463 USED TO CORRECT STANDARD GASOLINE EMISSION TEST CELL FUEL CONSUMPTION RESULTS FOR PROPANE FUEL.

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TABLE 3 CVS FUEL CONSUMPTION AND EMISSION TEST RESULTS

VEHICLE	METRAGE	FUEL	TEST #	F.C.(L/100 km) CITY	F.C.(L/100 km) HWY	VECR * CITY	VECR * HWY	COMMENTS
6 CYL AUTO TRANS -COMPARISON VAN	100	INDOLENE	2777	15.02	12.50			
-PROGRAM VAN 443	1034	PROPANE	0597	18.04	15.30	.85	.87	HEAVY DUTY CYCLE VEH.
-COMPARISON VAN	7624	INDOLENE	3331	13.43	11.83			
-PROGRAM VAN 443	8772	PROPANE	2535	17.26	14.49	.91	.87	HEAVY DUTY CYCLE VEH.
8 CYL AUTO TRANS -COMPARISON VAN	117	INDOLENE	2756	18.09	12.49			
-PROGRAM VAN 584	438	PROPANE	0637	20.75	15.83	.81	.90	HEAVY DUTY CYCLE VEH.
-COMPARISON VAN	6373	INDOLENE	3245	17.16	12.31			
-PROGRAM VAN 584	6400	PROPANE	4079	19.88	15.72	.82	.91	HEAVY DUTY CYCLE VEH.
6 CYL AUTO TRANS -EXT'D METRAGE CAR	7910	INDOLENE	3426	13.24	9.09			LEASE CAR - A HANCOX
-PROGRAM TAXI 486	8600	PROPANE	1644	15.02	11.44	.81	.89	
8 CYL AUTO TRANS -EXT'D METRAGE CAR	7589	INDOLENE	2537	14.52	9.45			LEASE CAR - A SHAMESS
-PROGRAM TAXI 485	3420	PROPANE	0362	18.67	12.54	.91	.94	
4 CYL MAN. TRANS -EXT'D METRAGE CAR	6802	INDOLENE	2608	9.37	6.46			EMPLL^H'E CAR - ROBERTSON
-PROG. FWD CAR 415	9462	PROPANE	3373	11.80	8.39	.89	.92	
4 CYL AUTO TRANS -EXT'D METRAGE CAR	5490	INDOLENE	2537	9.92	6.94			LEASE CAR - W HOUDE
-PROG. FWD CAR 416	6907	PROPANE	3148	12.12	9.67	.87	.99	

* VECR = VEHICLE ENERGY CONSUMPTION RATIO = $\frac{\text{L/(100 km) PROPANE}}{\text{L/(100 km) INDOLENE}} \times .71$ WHERE .71 = $\frac{\text{AVG JOULES/L PROPANE}}{\text{AVG JOULES/L INDOLENE}} = \frac{23580}{33020}$

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TABLE 4 AS-TESTED PROPANE/INDOLENE VEHICLE FUEL CONSUMPTION COMPARISONS AND ENERGY CONSUMPTION RATIOS

VEHICLE		AREA	FUEL	METRAGE	USABLE DATA FOR F.C. CALCULATIONS		AVG. F.C.	VECR	COMMENTS
					METRAGE	FUEL	L/(100km)		
8 CYL AUTO TRANS									
COMPARISON COMMUTER VAN		WINDSOR	GASOLINE	18732	18110	3956	21.8		5.9 L J VINCENT
PROGRAM COMMUTER VAN	#274	WINDSOR	PROPANE	30957	30479	6547 *	21.5		
PROGRAM COMMUTER VAN	#275	WINDSOR	PROPANE	38558	34271	7681 *	22.4		
PROGRAM COMMUTER VAN	#276	WINDSOR	PROPANE	29635	28502	7016 *	24.6	.74	
6 CYL AUTO TRANS									
COMPARISON VAN		WINDSOR	GASOLINE	11383	9378	1468	15.8		POOL R MAZUREK
PROGRAM VAN	#443	ONTARIO	PROPANE	19200	8150	1423	17.5	.83	
8 CYL AUTO TRANS									
COMPARISON VAN		WINDSOR	GASOLINE	17778	3350	651	19.5		POOL G WISE
PROGRAM VAN	#584	EDMONTON	PROPANE	7500	5686	1306	23.0	.88	
6 CYL AUTO TRANS									
COMPARISON CAR		WINDSOR	GASOLINE	6003	2540	376	14.8		LEASE CAR K DYE
PROGRAM TAXI	#219	TORONTO	PROPANE	20331	13106	2068 *	15.8		
PROGRAM TAXI	#486	QUEBEC	PROPANE	17832	6194	1100 *	17.8	.85	
8 CYL AUTO TRANS									
COMPARISON CAR		WINDSOR	GASOLINE	4747	1126	160	14.3		LEASE CAR R WILSON
PROGRAM TAXI	#485	EDMONTON	PROPANE	10847	9027	1552	17.2	.90	2.4 AXLE RATIO
4 CYL MAN TRANS									
COMPARISON CARS		WINDSOR	GASOLINE	-	4802	465	10.0		6 LEASE CAR AVG.
PROGRAM FWD CAR	#415	WINDSOR	PROPANE	22000	7310	904	12.4	.93	COURIER SERVICE
4 CYL AUTO TRANS									
COMPARISON CARS		WINDSOR	GASOLINE	14382	8204	696	8.5		LEASE J JACKSON
PROGRAM FWD CAR	#416	WINDSOR	PROPANE	30236	8068	749	9.3	.82	COURIER SERVICE

VECR = VEHICLE ENERGY CONSUMPTION RATIO = $\frac{\text{L/(100 km) PROPANE}}{\text{L/(100 km) GASOLINE}} \times .75$

WHERE .75 = $\frac{\text{Grade 1 Propane}}{\text{TYPICAL kJ/L GASOLINE}} = \frac{23580}{31650}$

RANGE OF kJ/L GASOLINE : 31060-32490 (15°C)

NOTE: IT WAS NOT POSSIBLE, OTHER THAN FOR COMMUTER VANS AND FWD CARS, TO MATCH THE TYPE OF SERVICE IN MAKING THESE COMPARISONS

* FUEL CONSUMPTION FOR ALL PROPANE VEHICLES OF A TYPE WERE AVERAGED BEFORE CALCULATING VECR

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TABLE 5 IN-USE PROPANE/GASOLINE VEHICLE FUEL CONSUMPTION COMPARISONS AND ENERGY CONSUMPTION RATIOS

4.6 Analysis of Driver Questionnaire Results

Completed questionnaires from drivers of the vehicles were returned to Product Engineering in Windsor. A summary of the driveability and performance ratings from these questionnaires is shown in Table 6. The ratings are predominantly satisfactory to excellent; however, the "poor" ratings and the "driver comment" problem categories shown in Table 7 point out several conditions that our own experience and testing have substantiated and partially defined or corrected. Problem-related comments were specifically solicited by the questionnaire.

- Cold weather start-up problems: These occurred after an overnight soak at temperatures around -20°C without benefit of an engine block heater. A few no-starts were encountered, but the more typical problem involved a successful start and operation for a few seconds followed by a die-out and a lengthy period during which restarting was very difficult. We are still investigating, but it is now clear that the vaporizer is unable to convert all the

	POOR	SATISFACTORY	GOOD	EXCELLENT
COLD STARTING	9	34	100	142
COLD IDLING	31	34	113	109
COLD OPERATION	9	20	129	125
WARM STARTING	2	9	110	101
WARM IDLING	2	23	107	171
WARM OPERATION	2	12	116	173
ACCELERATION	20	59	140	62
	---	---	---	---
TOTALS	75 (4%)	191 (10%)	815 (41%)	883 (45%)

TABLE 6 DRIVER QUESTIONNAIRE RATING SUMMARY

CATEGORY	NUMBER OF COMMENTS	PERCENT
STARTS UP, RUNS, AND PERFORMS WELL 12 vehicles; 274(8AVW), 275(8AVW), 584(8AVT), 443(6AVT), 097(8APT), 679(6MPT), 131(6APT), 485(8AMT), 219(6AMT), 486(6AMT), 415(4MKT), 416(4AKT) +	156 *	51 %
COLD WEATHER START-UP AND RUN PROBLEMS 10 vehicles; 274(8AVW), 275(8AVW), 276(8AVW), 584(8AVT), 443(6AVT), 442(6MVT), 097(8APT), 485(8AMT), 219(6AMT), 486(6AMT)	37	12 %
COLD IDLING PROBLEMS 7 vehicles; 275(8AVW), 276(8AVW), 584(8AVT), 443(6AVT), 097(8APT), 485(6AMT), 416(4AKT)	18	6 %
COLD WEATHER DECELERATION DIE OUT 2 vehicles; 275(8AVW), 584(8AVT)	2	1 %
REDUCED HEATER PERFORMANCE 5 vehicles; 274(8AVW), 276(8AVW), 584(8AVT), 485(8AMT), 486(6AMT)	15	5 %
INADEQUATE ACCELERATION 7 vehicles; 275(8AVW), 276(8AVW), 443(6AVT), 442(6MVT), 679(6MPT), 131(6APT), 485(8AMT)	22	7 %
INACCURATE FUEL GAUGE 6 vehicles; 276(8AVW), 584(8AVT), 097(8APT), 485(8AMT), 219(6AMT), 486(6AMT)	14	5 %
INSUFFICIENT FUEL TANK SIZE - RANGE 2 vehicles; 584(8AVT), 097(8APT)	9	3 %
OTHER 10 vehicles; 274(8AVW), 276(8AVW), 584(8AVT), 443(6AVT), 097(8APT), 679(6MPT), 131(6APT), 485(8AMT), 219(6AMT), 486(6AMT)	31	10 %
TOTAL	304	100 %

* Including 107 questionnaires with no comments but good to excellent ratings indicate general satisfaction with vehicle

\+ List of vehicles whose driver comments were grouped in this catagory

Code: XXX (XXXX)

- last 3 digits of VIN
- # of Cylinders: 6 - six cyl.; 8 - eight cyl.; 4 - four cyl.
- Transmission: A - auto.; M - man.
- Body & Type: VW - van wagon; VT - van truck; PT - pickup truck; MT - M body taxi; KT - K body taxi FWD

TABLE 7 DRIVER QUESTIONNAIRE COMMENT SUMMARY

needed propane to vapour during the start-up period. Liquid passes through it, upsetting mixture control and causing a flooding condition during subsequent restart attempts. To correct this condition a larger capacity vaporizer has been released for some applications. More cold-weather testing would be virtually certain to lead to a better solution. A throttle-operated cut-out switch to override the priming function during a post-flooding restart was developed for all engines. Use of an engine block heater (highly recommended in cold areas) eliminates the condition.

- Cold idling problem: This was an engine die-out condition while idling which was caused by not being able to overcome the differing hot and cold engine friction successfully with one idle speed setting. The condition has now been alleviated by a two-speed idle system that is controlled by the engine block coolant temperature to allow use of a fast idle speed for stable cold engine start-up (high engine friction) and a slower warmed up idle speed (low engine friction) for overall efficient operation.

- Cold weather deceleration die-outs: This problem occurred at temperatures below -20°C when decelerating sharply from highway speeds; e.g., pulling off the highway into a service station. At temperatures approaching -40°C, the condition occurred when decelerating from city speeds. It is presently believed to be the result of an instantaneous, overrich condition caused by the inability of the vaporizer to respond quickly to the changed fuel flow requirements. The larger capacity vaporizer alleviates this condition.

- Reduced heater performance: The time required for the heater to provide adequate heat was reported to be noticeably greater than with gasoline vehicles and in very cold ambients, the heater would not attain a satisfactory output. The condition was largely caused by a conventional engine coolant circuit to the vaporizer which shared its return line with the vehicle's heater. This reduced the normal flow rate of engine coolant to the heater core with the observed effect on heater output. An improved engine coolant circuit to the vaporizer which isolates the vaporizer return line from the heater return was developed for the three taxis and will be used on 1983 model year vehicles. We expect it to provide excellent heater performance during both engine warm-up and cruise conditions. It is probable that the lower heat rejection of the more efficient propane engine contributes to the problem by slightly increasing the engine coolant warm-up time.

- Inadequate acceleration or underpowered: Thirteen of the twenty-two comments in this category originated from the police drivers in the Edmonton area who were evaluating the eight-cylinder taxi for pursuit duty. It was rarely judged inadequate for other types of service. One or two comments relating to maximum load acceleration were also received from commuter van drivers. A trial compression ratio increase to one of the three commuter van engines has resulted in favourable comments from the driver. We have also developed and demonstrated an eight-cylinder propane police car that will meet the requirements of police forces.

- Inaccurate fuel gauge: Among the contributing factors to this problem were incorrect calibration of the sending unit to the instrument panel gauge, magnetic uncoupling of the sending unit from the float mechanism, and coarse design of the float mechanism. The calibration and magnetic uncoupling problems have been reduced substantially.

- Inadequate trunk space: This situation relates to passenger cars, and results from encroachment of the large fuel tanks into the normal cargo and spare tire space. In the case of the taxis where the trunk space was most cramped, a more space-efficient single-tank installation was developed and retrofitted. Those evaluators who have seen both the before and after installations were pleased with the improved trunk space without loss of fuel capacity.

Some of the improvements derived from our development work noted above were not incorporated into the vehicles until late in the program and would not be reflected in the driver questionnaire comments. Even so, a surprisingly large percentage of unsolicited laudatory comments were received in the "starts up and performs well" category.

5. FUTURE DESIGN NEEDS

Chrysler Canada Ltd. Product Engineering has expended 1300 more development hours on these prototype vehicles than was originally planned. This extra effort and the improvements derived from it have also benefited our ongoing propane vehicle production program but a great deal more of this type of work remains to be done.

We are working to decrease the cost and complexity of assembling propane vehicles and have recently reviewed with manufacturing a series of proposals for increased on-line assembly of our current production propane vehicles (see Table 8). Chrysler Corporation's Manufacturing Division, however, is very conscious of the effect the added complexity of low volume vehicles can have on plant quality and is therefore cautious about adding to the number of parts and assembly processes in our assembly plants. These areas of concern must be addressed to achieve the savings inherent in higher levels of on-line production.

The present federal safety standard for propane vehicles references other standards which tend to suffer from their writers' lack of automotive design experience. It is now possible in some areas to interpret the meaning of the complete package in more than one way. Chrysler Canada's interpretation of these areas permits the design of a cost and space-efficient vehicle, but clarification should be pursued. The present ambiguity presents a risk of criticism based on misunderstanding, plus a risk that reinterpretation might force design changes which would diminish the customer acceptance of these vehicles.

To satisfy, at minimum price differentials, the level of expectation that consumers have traditionally held for motor vehicles, and to derive the maximum benefit from the fuel, increased design and development effort should be directed to the following areas:

5.1 Engine Systems

- valve and valve seat insert material for greater engine durability
- valve timing (camshafts) for best performance and driveability
- higher compression ratios for improved fuel consumption and performance
- combustion chamber shapes
- intake manifolds for better fuel distribution
- oil requirements to provide satisfactory oil change interval and component protection
- ignition timing controls

METHOD NO.	ASSEMBLY PLANT INSTALLATION	PREP CENTRE INSTALLATION	ADDITIONAL COST *	SAVINGS vs No.1	UNIQUE PARTS IN ASSY PLANT PER VEHICLE	UNIQUE PARTS IN ASSY PLANT TOTAL IN PLANT
1.	PDE # and Standard Gasoline Components	Propane Engine Components, Fuel Lines, Fillers and Tanks	$454	-	1	5
2.	PDE, Recycled Carburetor and Temporary Gasoline Tank	Propane Engine Components, Fuel lines, Filler, and Tank	$355	$99	4	9
3.	Pre-dressed PDE + and Temporary Propane Tank	Propane Fuel Lines, Filler and Tank	$264	$190	2	6
4.	PDE, Propane Engine Components, and Temporary Propane Tank	Propane Fuel Lines, Filler and Tank	$194	$259	15	29
5.	PDE, Propane Engine Components, Fuel Lines and Temporary Propane Tank	Propane Fuel Filler and Tank	$152	$302	23	40
6.	PDE, Propane Engine Components, Fuel Lines, Filler and Temporary Fuel Tank	Propane Fuel Tank	$118	$335	30	48

* Includes all Prep Centre labour, variable burden and all discarded parts. Does not include propane parts.

PDE - Propane-Designated Engine shipping assembly that has internal engine modifications appropriate for propane

+ Pre-dressed PDE - Propane-Designated Engine shipping assembly that has been pre-dressed with external propane components prior to delivery to assembly plant

1982-08-30

TABLE 8 ALTERNATE ASSEMBLY METHODS

5.2 Carburetion Systems

- new or improved vaporizer designs that will function well in extremes of Canadian climate
- carburetor refinements to control air fuel ratios better throughout the speed and load range
- improved idle speed controls

5.3 Vehicle Fuel Systems

- lightweight fuel tank designs utilizing alternate materials and manufacturing techniques for light, compact vehicles
- unconventional fuel tank shapes and configurations which better utilize vehicle or underbody space and increase vehicle driving range
- new fuel tank configurations to provide the 20% vapour space requirement
- 80% automatic stop-fill valves
- new fuel tank multi-functional valves; e.g., shut-off valves which incorporate remote operation and hydrostatic relief
- excess flow valves that function properly with small pressure drops at low ambient temperature

5.4 On-Line Assembly Plant Operations

- study of assembly plant processes for greater on-line integration of propane and gasoline vehicle assembly
- develop methods for handling in-plant fueling of propane vehicles
- greater modularization of components to decrease the number and complexity of assembly line operations

6. OPTION COST AND PRICE OF PROPANE VEHICLES

The cost penalties associated with the assembly of an eight-cylinder van by different manufacturing methods were derived from information gained in developing and building the fourteen program vehicles and from Chrysler Canada Ltd.'s regular propane vehicle production program. Table 9 was prepared by the Product Engineering, Purchasing, Manufacturing, and Finance Departments after an extensive study of parts, tooling, and manufacturing costs for the present (method A) and probable future methods of production at the Pillette Road Truck Assembly Plant. Although Chrysler Canada Ltd. is presently manufacturing by method A its current price is set at the method B amount for competitive reasons. The added costs of assembling by method A over method B are being absorbed by the Company.

The present manufacturing method (A) allows for building the low-volume propane vehicles with as little disruption as possible in the assembly plants and their conversion to propane operation at a Chrysler Canada Ltd. prep centre. This method has the advantage of keeping low-volume operations and added parts out of the assembly plants and concentrating them at one place. We are convinced, however, that the unnecessary, added costs of this method; i.e., cost to assemble and then disassemble unnecessary gasoline parts, cost of non-reusable gasoline parts removed at the prep centre, and cost of shipping vehicles to and from the prep centre outweigh the assembly plant complexity argument and that we should progress to method B or C. We hope to initiate a trial run at one of our assembly plants soon.

Management at the Pillette Road Truck Assembly Plant believes that methods B or C could be achieved quickly if volumes were increased to approximately 1500 units per year or if run batches of 350 or more could be scheduled at a time. Temporary incentives which make this level of sales possible could result in cost reductions which in turn could help make the higher sales volume self-sustaining.

APPROX. VOLUME PER QUARTER	METHOD OF MANUFACTURE	COST PENALTY OVER METHOD "C"	RETAIL OPTION PRICE
50	A - Assembly Plant - install propane prepped engine - leave off as many unnecessary parts as possible Prep Centre - remove all unnecessary gasoline parts and return major components to Assembly Plant for reuse - install propane carburetion and fuel system parts	$450.-	$1411.65 ^
375	B - Assembly Plant - install propane-prepped engine; propane carburetion parts; propane fuel lines, tank filler parts, and fuel tank mounting bracket using a temporary fuel tank for mobility Prep Centre - remove temporary propane tank and refill - install permanent propane fuel tank	$150.-	$1411.65
500 - 2000	C - Assembly Plant - install all propane components using temporary propane fuel tank for in-plant mobility - connect and fuel up propane tank outside plant	-	N.A. #

^ current "method A" assembled vehicles are priced at "method B" amount to meet competitive pressures
# future pricing structure is unresolved

1982-12-01

TABLE 9 ALTERNATE ASSEMBLY METHODS AND ESTIMATED COST PENALTIES AND CURRENT RETAIL PRICE

7. FUTURE SALES POTENTIAL OF PROPANE VEHICLES

The Sales and Marketing Group of Chrysler Canada Ltd. sent a propane vehicle specification mailing (see Appendix F) to 7300 designated fleet accounts in June of this year. In September the Regional Fleet Sales Managers were canvassed for their estimate of Chrysler Canada Ltd. propane vehicle sales potential based on the responses from the June mailing and from their contacts with the accounts as a result of this demonstration program. National fleet accounts were also surveyed through normal contact channels.

The forecast sales figures shown in Table 10 were developed by the Sales and Marketing Group with the assumption that no significant, detrimental change in relative price of propane and gasoline fuels or in government incentives would occur over the period. It is clear that, as of this writing, continuing supportive government actions are required to attain the threshold volumes necessary to permit use of the most cost effective assembly and purchasing methods and to achieve sales volumes that are in line with the expected available propane motor fuel supply.

SALES REGIONS *	1983 CARS	1983 TRUCKS	1984 CARS	1984 TRUCKS	1985 CARS	1985 TRUCKS
ONTARIO	1530	3640	1960	4700	2730	6580
QUEBEC	120	320	160	420	210	580
ATLANTIC			20	40	30	60
PRAIRIE	120	260	160	330	220	460
ALBERTA	60	260	80	330	110	470
PACIFIC	170	520	220	680	300	950
NATIONAL	2000	5000	2600	6500	3600	9100

Source: Chrysler Canada Ltd. Sales and Marketing Group

* Sales region boundaries are not coincident with provincial boundaries

1982-10 30

TABLE 10 TOTAL INDUSTRY OEM PROPANE VEHICLE SALES FORECAST

Since these estimates were made:

1. Sales forecasts for both gasoline and propane vehicles have been lowered, particularly for trucks.

2. Retail propane prices have followed the upward movement of crude oil and gasoline prices but have not followed subsequent price declines. The result has been an erosion of the propane/gasoline price differential and a general reduction in interest in propane.

1983-03-21

8. CONCLUSIONS AND RECOMMENDATIONS

The results of this project, together with experience gained from our ongoing propane vehicle development and production programs, have led to the following conclusions and recommendations:

- A keen interest in propane vehicles exists among fleet owners that is not yet reflected in new vehicle purchases.

- Ratings by the drivers of the vehicles were predominately (96%) "satisfactory" to "excellent." Comments from drivers regarding "poor" ratings pointed out several problems, mainly relating to cold weather operation, which in most cases were corrected or alleviated during the program.

- These demonstration vehicles are considered representative of the present level of development. When compared to their gasoline counterparts, the average energy consumption ratios for all vehicle types were determined to be .86 (14% better) on the city cycle and .91 (9% better) on the highway cycle, using the Transport Canada dynamometer test procedure. These test results were supported by fuel consumption data reported by users of the vehicles which indicated an average "in-use" energy consumption ratio of .85 (15% better).

- The advantages of propane vehicles over gasoline vehicles tend to increase at low engine temperatures. The fuel efficiency advantage is enhanced because there is no choke cycle, and the fast idle is slower and ends sooner. Absence of manifold vaporization and distribution difficulties of the conventional gasoline engine at low temperatures results in superior driveability and less degradation in emissions. Propane vehicles, therefore, are better suited to short trips under Canadian winter conditions than are gasoline vehicles.

- It is clear from our marketing analysis that continuing government supportive actions are required to attain propane motor fuel use goals.

- Approximate sales volumes (per vehicle type) of 1500 units per year or run batches of 350 or more vehicles at a time would permit higher levels of on-line assembly with substantial cost savings.

- Propane vehicles may have limited long-range potential for use in urban commercial service which involves long periods of operation in stop-and-go traffic. Diesel vehicles have dramatically lower fuel costs in this type of service and it is unlikely that changes in the relative prices of fuels will be great enough to eliminate this advantage. Reasonably priced diesel vehicles are becoming increasingly available for this application.

- Federal government incentives should therefore be extended to private owners who purchase lightweight, fuel-efficient, propane vehicles. This selective broadening of incentives would take additional vehicles off gasoline without creating an undesirable incentive for continued use of large private vehicles. The cost recovery period for the propane option on larger vehicles is already relatively short because of their greater fuel throughput.

- High priority should be given to improving the design of components that affect the starting and operating characteristics of propane vehicles in cold weather. Additional design and development work needs to be directed to the following areas: engine efficiency and durability, 80% automatic shut-off valves, unconventional tank shapes, modularization of components, and assembly plant process studies to integrate propane systems into regular assembly plant procedures.

There are related technical and consumer-attitude factors that are inhibiting the faster expansion of the propane vehicle fleet. Poorly designed or low-cost propane vehicle fuel systems and installations have resulted in serious driveability, performance, fuel consumption, and durability problems which have caused costly down-time, warranty disputes, and even retrofitting to gasoline. Our contacts with buyers over the past year have provided some insight into negative consumer attitudes toward propane and propane vehicles that can be summarized as follows:

- There is a widespread concern among fleet operators that the pump prices of propane and gasoline will be allowed to converge until there is no longer a fuel cost advantage to offset the inconveniences of operating on propane.

- Propane's excellent properties as a motor fuel are not widely known.

- Knowledge of the expanding Canadian automotive propane distribution network is almost non-existent.

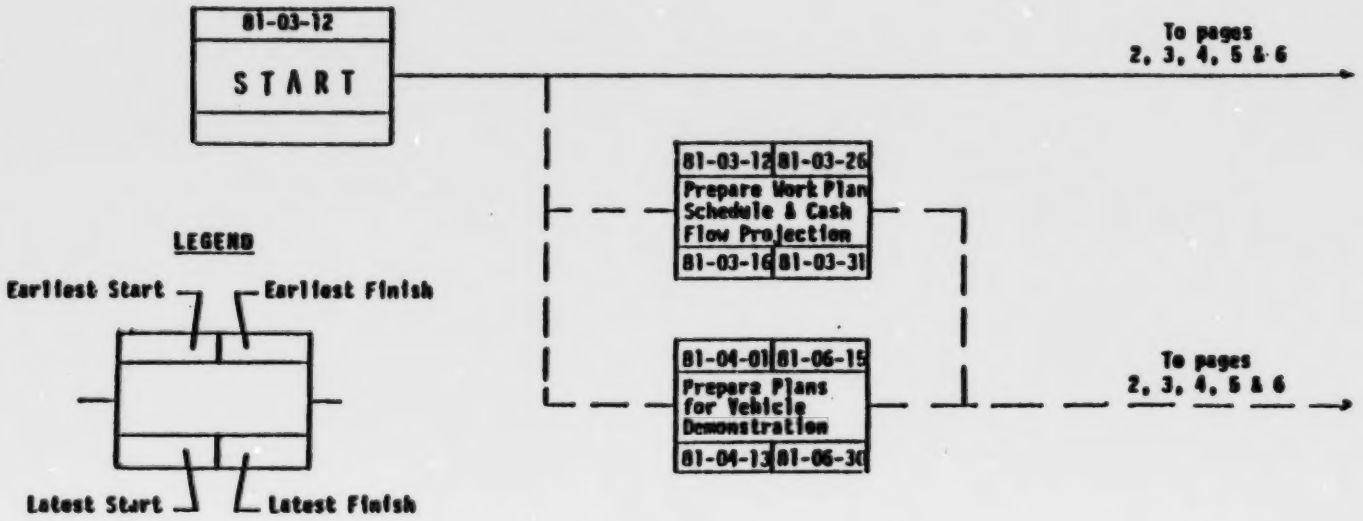
- Propane fuel is generally thought to be inherently less safe than gasoline.

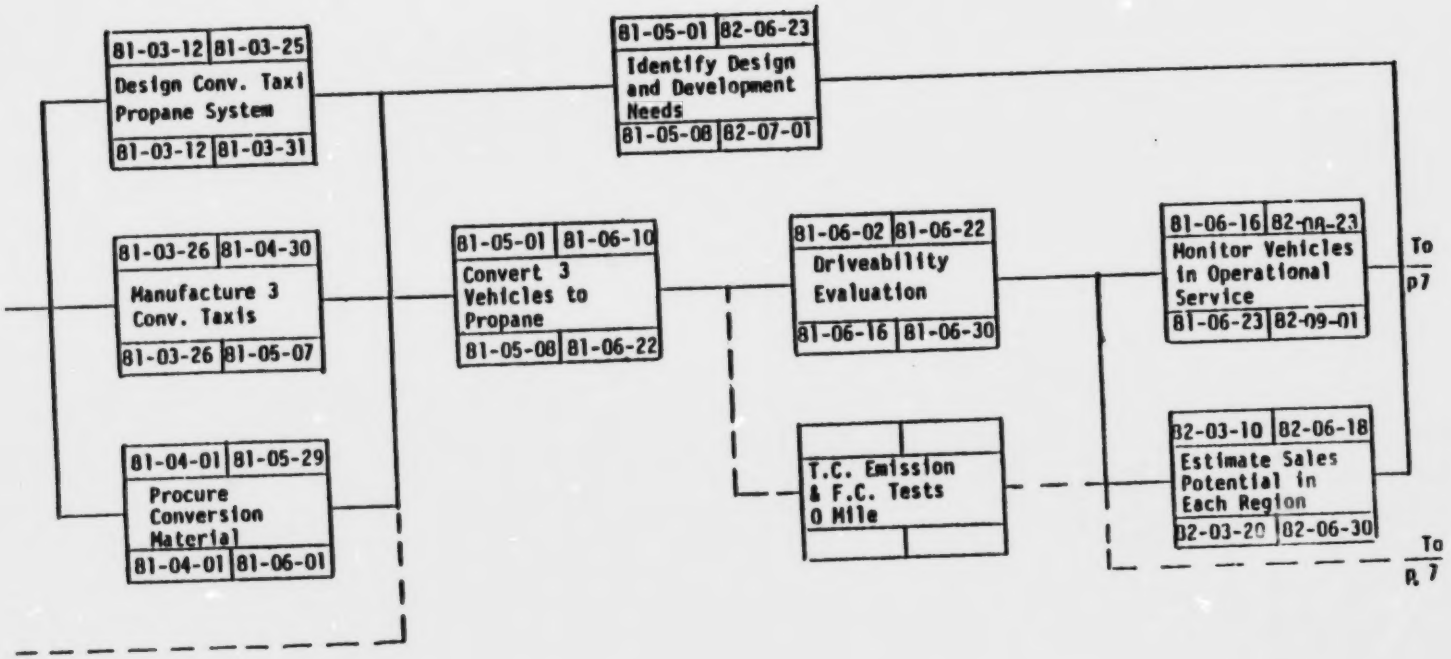
The work to be done notwithstanding, these demonstration vehicles were well received in the field, generated a large number of positive comments, and have had a significant impact on Canadian fleet operator awareness of propane and propane vehicles and of government and industry efforts to popularize their use. The building and demonstration of these prototype vehicles have also provided Chrysler Canada Ltd. with important development and marketing experience and information that is already being usefully applied to current propane vehicle production programs.

APPENDIX A

EVALUATION OF PROPANE-FUELED VEHICLES DESIGNED FOR ON-LINE PRODUCTION

- WORK PLAN AND SCHEDULED ACTIVITIES -

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81-03-12 | 81-03-31
81-05-01 | 82-06-23
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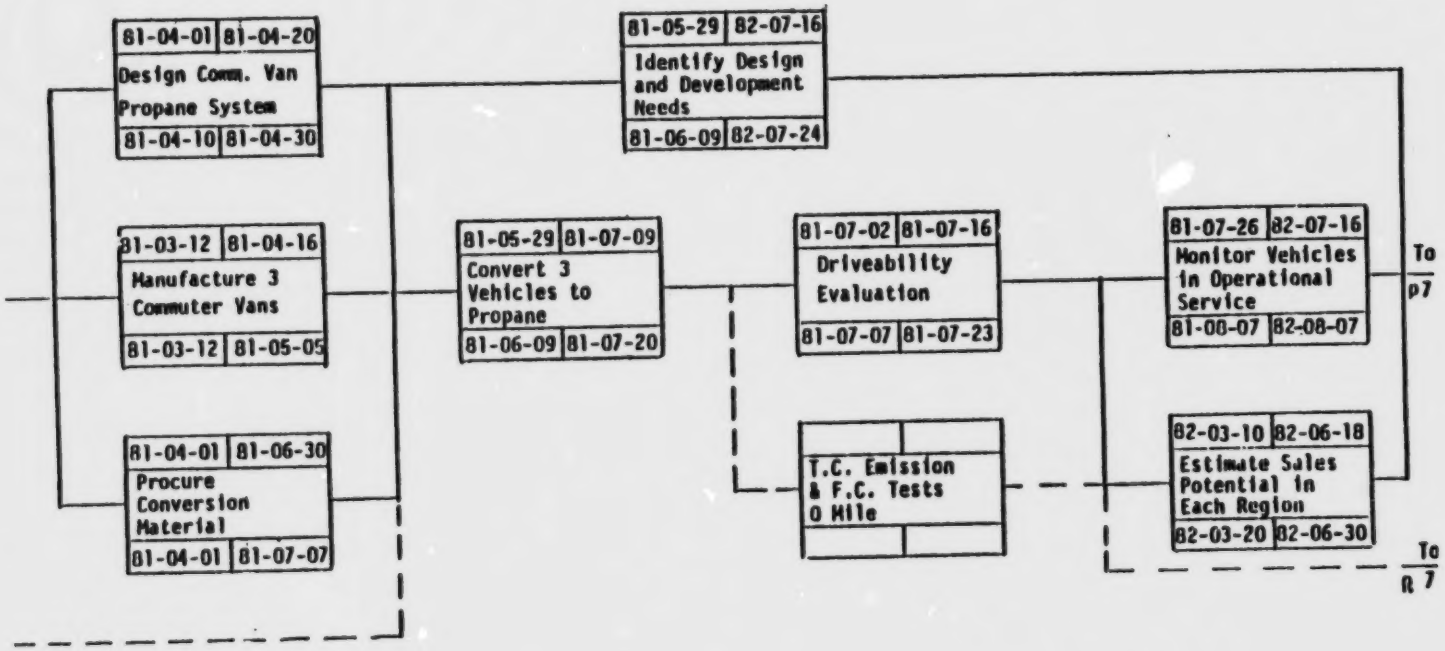
81-05-08 | 82-07-01
81-03-26 | 81-04-30
Manufacture 3 Conv. Taxis
81-03-26 | 81-05-07
81-05-01 | 81-06-10
Convert 3 Vehicles to Propane
81-05-08 | 81-06-22
81-06-02 | 81-06-22
Driveability Evaluation
81-06-16 | 81-06-30
81-06-16 | 82-08-23
Monitor Vehicles in Operational Service
81-06-23 | 82-09-01
To p7
81-04-01 | 81-05-29
Procure Conversion Material
81-04-01 | 81-06-01
T.C. Emission & F.C. Tests 0 Mile
82-03-10 | 82-06-18
Estimate Sales Potential in Each Region
82-03-20 | 82-06-30
To p. 7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81-03-12 | 81-04-16
Manufacture 3 Commuter Vans
81-03-12 | 81-05-05
81-05-29 | 81-07-09
Convert 3 Vehicles to Propane
81-06-09 | 81-07-20
81-07-02 | 81-07-16
Driveability Evaluation
81-07-07 | 81-07-23
81-07-26 | 82-07-16
Monitor Vehicles in Operational Service
81-08-07 | 82-08-07
To p7
81-04-01 | 81-06-30
Procure Conversion Material
81-04-01 | 81-07-07
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Estimate Sales Potential in Each Region
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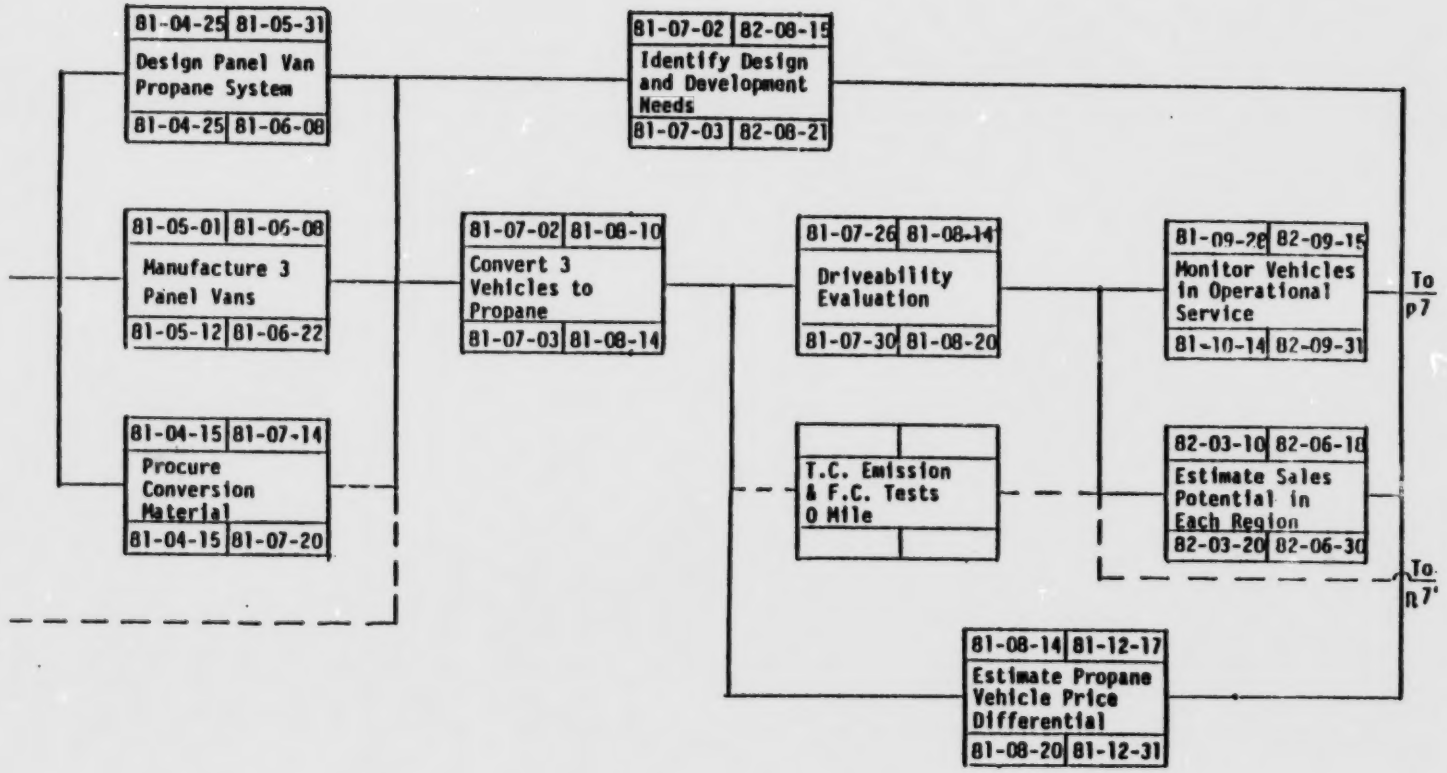
To R 7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Manufacture 3 Panel Vans
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Convert 3 Vehicles to Propane
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81-07-26 81-08-14
Driveability Evaluation
81-07-30 81-08-20
81-09-28 82-09-15
Monitor Vehicles in Operational Service
81-10-14 82-09-31
To p7
81-04-15 81-07-14
Procure Conversion Material
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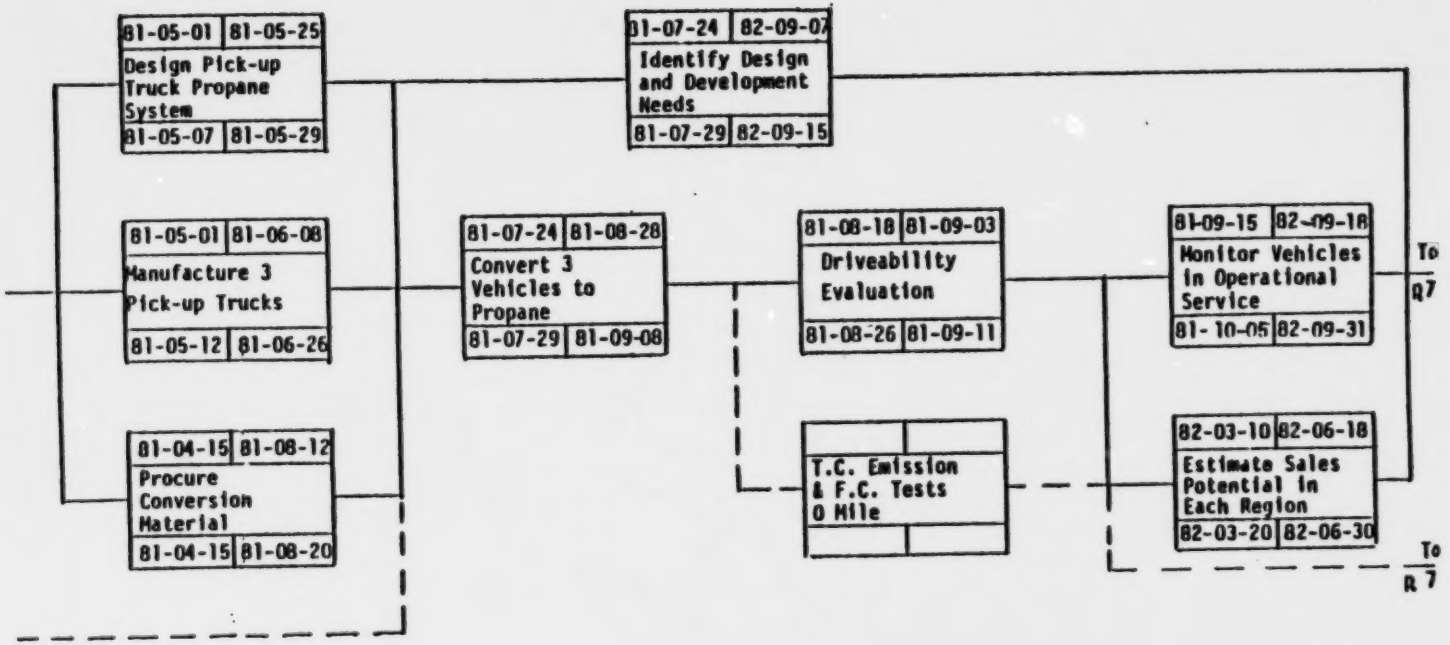
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82-09-15
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81-06-08
Manufacture 3 Pick-up Trucks
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Convert 3 Vehicles to Propane
81-07-29
81-09-08
81-08-18
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Driveability Evaluation
81-08-26
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Monitor Vehicles in Operational Service
81-10-05
82-09-31
To Q7
81-04-15
81-08-12
Procure Conversion Material
81-04-15
81-08-20
T.C. Emission & F.C. Tests 0 Mile
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82-06-18
Estimate Sales Potential in Each Region
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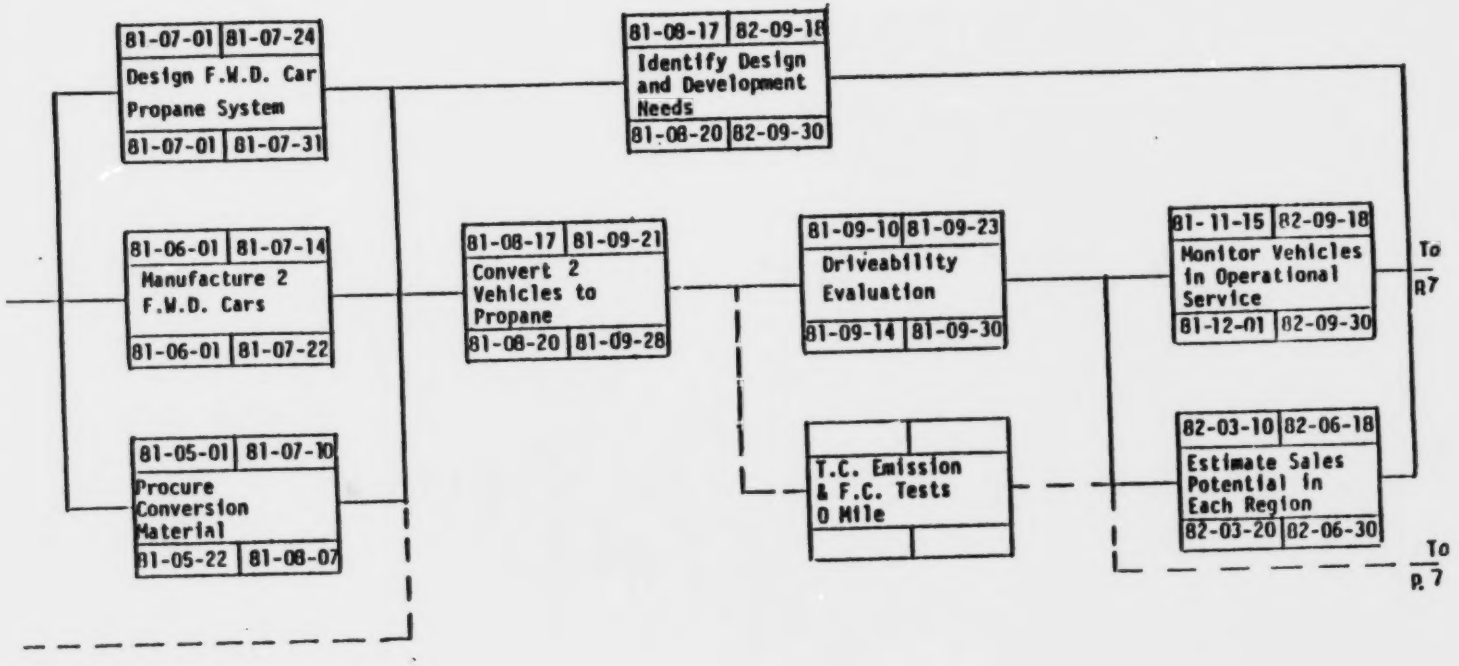
82-06-30
To R7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Design F.W.D. Car Propane System
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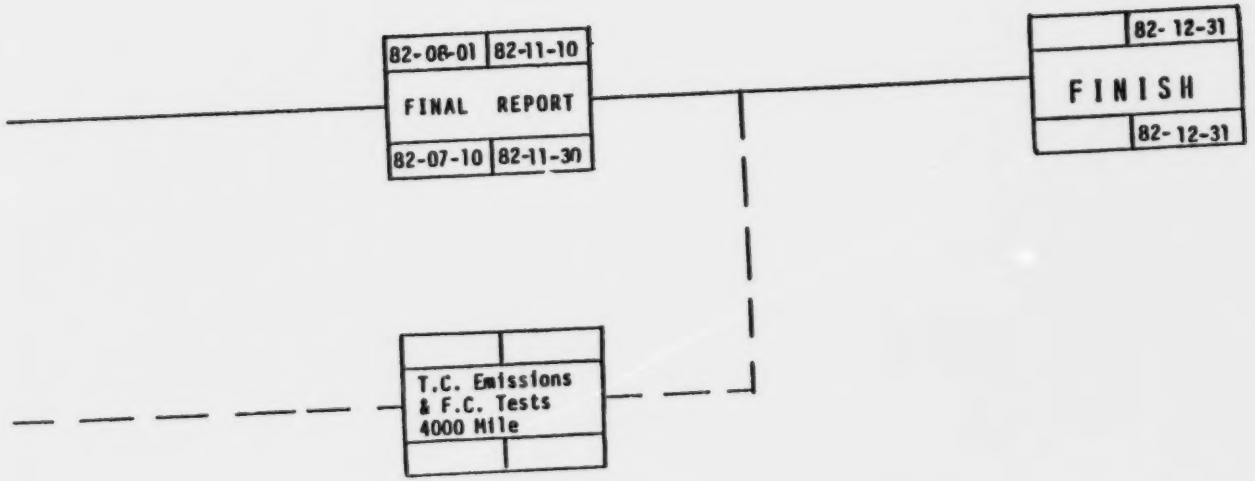
Identify Design and Development Needs
81-08-20 | 82-09-30
81-06-01 | 81-07-14
Manufacture 2 F.W.D. Cars
81-06-01 | 81-07-22
81-08-17 | 81-09-21
Convert 2 Vehicles to Propane
81-08-20 | 81-09-28
81-09-10 | 81-09-23
Driveability Evaluation
81-09-14 | 81-09-30
81-11-15 | 82-09-18
Monitor Vehicles in Operational Service
81-12-01 | 82-09-30
To R7
81-05-01 | 81-07-10
Procure Conversion Material
81-05-22 | 81-08-07
T.C. Emission & F.C. Tests 0 Mile
82-03-10 | 82-06-18
Estimate Sales Potential in Each Region
82-03-20 | 82-06-30
To P. 7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FINISH
82-12-31
T.C. Emissions
& F.C. Tests
4000 Mile

FINAL ISSUE
Sept. 12, 1979

APPENDIX B

VEHICLE DRIVEABILITY EVALUATION PROCEDURE

The "SID" (Start, Idle, Drive) rating system has been used by various Corporate activities since its development in June, 1975 by R. S. Rarey. The original rating definitions have proven very useful but sometimes ambiguous. Therefore, the rating definitions were revised with the approval of the Carburetor and Driveability CWRP Committee in June, 1979. Vehicles are evaluated for several functions under various vehicle conditions.

FUNCTIONS: Engine Starting

Idle Rating

Car in Motion - Driveability

Performance

Spark Knock

Stalls

CONDITIONS: Cold

During Warm-Up

Warmed-Up

After Hot Soak

After Partial Cool-Down

A 1 to 9 (9 is best) numerical rating system is used for the rating functions. The rating number is intended to represent the driver satisfaction level. Table 1 defines the satisfaction levels in general terms. Tables 2, 3, 4 and 5 relate these same definitions to the Start, Idle, Drive, and Performance respectively.

Downgrade for stalling is reflected in the appropriate S.I.D. function. Spark knock is noted separately from the drive evaluation.

I. STARTING

Vehicles are to be started in accordance with the procedure printed on Attachment 7. Starting performance is to be rated in accord with Table 2.

Die-outs and passouts occurring after a start, but before the car has been moved from the parking space, should be included in the starting rating by downgrading the potential starting rating in accordance with the severity of the condition experienced. A die-out is defined as an engine stall with the throttle in the closed position irrespective of vehicle movement.

Note: In cold starting a vehicle, the throttle is open to a fast idle cam position. It will be assumed that in this position, the throttle is closed since the throttle is against the designed stop.

A passout is an engine stall with throttle movement irrespective of vehicle movement. Downgrading of start due to stalls is in accordance with Table 2.

An asterisk (*) should be added to any rating which is downgraded for a stall.

A cold-start is defined as a vehicle which before being started, has been thoroughly warmed to normal operating condition, then soaked for a minimum of eight hours and a maximum of 18 hours. Three rating scales for different ambient temperature ranges are used (Table 2). Care must be exercised to use the correct rating scale for the appropriate temperature range.

A hot-start is one in which a fully warmed-up engine has soaked approximately .2 (12 min.) to .8 (48 min.) of an hour, dependent on ambient temperature. Hot-start is rated only above 10°C (50°F).

A partial cool-down (PCD) start is one in which the restart is applied to a vehicle fully warmed, after a soak of 1.5 to 4 hours. Both partial cool-down and hot start are illustrated graphically in Attachment 8. The importance of correctly noting soak time, ambient temperature, and start time when starting vehicles is stressed.

II. IDLE

The idle quality will be rated using a 1 to 9 scale, with the vehicle in gear (except for manual transmission vehicles). On vehicles equipped with air conditioning, the idle quality should be noted both with A/C and without A/C operational. Idle ratings placed in the S.I.D. matrix are without A/C operational. Idle ratings will not be downgraded for stalls as done for start, since idle ratings of 1 thru 3 will define this condition. Idle quality is to be rated in accord with Table 3. An asterisk (*) should be used whenever a die-out occurs.

III. DRIVE

The drive evaluation is comprised of four distinct areas: Cold (during warm-up); Warm; Hot; and Partial Cool-Down (PCD). The cold drive is judged from the point when the vehicle is placed in

III. DRIVE (Cont'd)

gear, after the cold start, and begins to move to the point of temperature equilibrium. An indication of equilibrium in the coolant temperature gauge indicates the end of the cold period. Cold drive will be evaluated by a series of light tip-ins (LTI), and heavy tip-ins (HTI) from rest, at one-tenth mile increments for the first mile, and two-tenth increments between one and three miles.

A fully warmed-up drive is the condition after the cold period is ended or when the engine has reached equilibrium. Warm drive is evaluated by driving the vehicle at various steady state speeds and acceleration modes from the steady state speeds indicated on the drive evaluation sheet. It should be noted that the acceleration modes during warm drive should not necessarily involve a downshift since this is evaluated in performance.

Hot drive is the portion of the evaluation which takes place after the fully warmed-up vehicle has soaked for a period of .2 (12 min.) to .8 (48 min.) of an hour. The vehicle is then started and driven away, utilizing a light tip-in. The drive evaluation should continue to temperature equilibrium. Ambient temperature must be above 10°C (50°F).

Partial cool-down (PCD) drive takes place after the fully warmed-up vehicle has soaked for a period of 1.5 to 4 hours. The vehicle is then started and driven away using a light tip-in. The drive rating includes all characteristics until the vehicle is warmed-up to equilibrium.

If the evaluator is uncertain of when temperature equilibrium occurs, the following guidelines may be used:

Hot Start	- 3 Minutes
Cold Starts Above 10°C (14°F)	- 10 Minutes
Partial Cool Down	- 10 Minutes
Cold Starts Below 10°C (14°F)	- 15 Minutes

The importance of comments in all aspects of the driveability evaluation is emphasized. Any peculiarities of the evaluation should be noted. Drive evaluation is to be rated in accord with Table 4. An asterisk (*) should be used whenever a die-out or passout occurs.

IV. PERFORMANCE

Performance rating is a relative indicator of how well the vehicle performs under heavy acceleration. Examples of performance evaluation would be WOT or nearly WOT acceleration from standing start, a high speed freeway traffic maneuver, or when merging into high speed freeway traffic from an entrance ramp. The rating must take into account which particular engine displacement/inertia weight/axle ratio combination is being evaluated. Obviously, one cannot expect a 225 R-Body to accelerate as well as a 360 high performance F-Body.

Since vehicle performance is difficult to measure accurately without the aid of stop watch, speedometer and test track, the subjective guidelines in Table 5 are to be used.

V. EXAMPLE

Following is an example of a completed evaluation matrix.

	COLD	WARM	HOT	PCD
START	5*	X	8	6
IDLE	6	5	5	3*
DRIVE	7	8	8	3*
PERFORMANCE	X	8	X	X

Cold Portion

The 5* rating represents a 3.0 second cold start time (above +20°F) with the rating downgraded 2 points for one die-out. The 6 idle rating represents idle quality with slight engine roughness and the 7 cold drive rating indicates driveability having one or more undesirable elements, but taking concentration to find.

Warm Portion

The 5 idle rating represents an irritating condition. A definite undesirable condition exists, but not to the extent that it is disturbing. The 8 driveability represents a trace of only one undesirable element that can be found. The 8 performance rating indicates a vehicle that under heavy acceleration, performs better than the customer would expect considering engine displacement/ inertia weight/axle ratio combination.

Hot Portion

The 8 start represents a 1.1 to 2.0 second crank with no die-outs. The 5 idle rating would be the same as described in the warm section and the 8 drive would also be the same as in the warm section.

PCD

The 6 start represents a 3.1 to 4.0 second crank with no die-outs. The 3 idle rating indicates an idle that would give the evaluator lack of confidence. The vehicle had die-outs and extremely rough idle. The 3 drive represents a condition that undermines the driver's confidence in the car's ability to perform reliably at all times.

Attachment 6 is a glossary of driveability terminology currently in use by Engineering, Stamping and Assembly Division Quality Control and Service. Attachment 9 is a copy of the Driveability Evaluation Form used by Stamping and Assembly Division Quality Control for evaluation of production vehicles.

J. W. Foster
J. W. Strausbaugh
September 12, 1979

"ATTACHMENTS"

1. Rating Definitions in Terms of Customer Satisfaction
2. Start Ratings
3. Idle Ratings
4. Drive Ratings
5. Performance Ratings
6. Glossary of Driveability Terms
7. Starting Procedure
8. Vehicle Cool-down Curve
9. Driveability Report Form - Stamping & Assembly Division
   - This form is used for all formal Driveability Evaluations conducted by the Stamping & Assembly Division.

Table 1

"RATING DEFINITIONS IN TERMS OF CUSTOMER SATISFACTION"

9. Exceptional - No defects; driver is truly impressed.

8. No Significant Deficiencies - Only traces of deficiencies can be found; driver is pleased.

7. Minor Deficiencies - Few deficiencies, all minor in nature; driver is satisfied.

6. Obvious, But Not Objectionable Problems - A definite undesirable characteristic exists, however, the driver does not consider it objectionable. Driver is generally satisfied.

5. Marginal - Borderline, driver is not particularly happy with car operation, but is not likely to complain unless irritated for some other reason.

4. Disturbing - An owner would seek corrective action.

3. Lack of Confidence - Condition is so severe as to cause driver to loose confidence in the ability of the vehicle to perform reliably though failure to perform is rare.

2. Unreliable - Periodic failure to perform.

1. Unpredictable - Erratic and uncontrollable failure to perform.

Table 2

"START RATING"

START TIME: Time applies to either first start or any subsequent restart, whichever is the longest.

START TIME	RATING: ALL STARTS EXCEPT COLD STARTS BELOW -8°C (20°F)	COLD STARTS BETWEEN -8°C & -18°C (20°F & 0°F)	COLD STARTS BETWEEN -18°C & -30°C (0°F & -20°F)
1.0 or Less	9	9	9
1.1 - 2.0	8	9	9
2.1 - 3.0	7	8	9
3.1 - 4.0	6	8	8
4.1 - 5.0	5	7	8
5.1 - 6.0	4	6	7
6.1 - 7.0	3	5	7
7.1 - 8.0	2	5	6
8.1 - 9.0	2	4	5
9.1 - 10.0	1	3	5
10.1 - 12.0	0	2	4
12.1 - 14.0	0	1	3
14.1 - 15.0	0	0	1
Over 15	0	0	0
STALLS			
STALLING DOWNGRADE			
1	2	1	1
2	5	3	2
3	6	5	3
4 or More	7	7	1 per stall

Table 3

"IDLE RATING"

RATING	DEFINITION
9	No trace of an undesirable element can be found and one cannot feel that the vehicle is running.
8	Engine operation is barely perceptible. Idle is totally smooth and flawless.
7	Engine vibration is noticeable but smooth and unobjectionable.
6	Consistent idle speed with slight engine roughness.
5	This would be an irritating condition, such as a moderately rough or pulsating idle.
4	Disturbing: An engine operation problem exists which is disturbing to the driver but is not serious enough to undermine the driver's confidence in the car's ability to continue running. An idle that causes severe driveline shock upon engagement or is very rough. This would be considered unacceptable.
3	Lack of Confidence: A condition exists which undermines the driver's confidence in the car's ability to perform reliably at all times. (Examples are extremely rough idle or decel die-outs after the vehicle comes to rest.)
2	Frequent die-outs.
1	Multiple die-outs, operation is erratic and uncontrollable.

Table 4

"DRIVE RATING"

RATING	DEFINITION
9	No trace of any indesirable element can be found and in addition, the car has exceptionally good responsive feel under all conditions.
8	Traces of undesirable elements can be found with extreme concentration or no undesirable characteristics but lacking the responsiveness and feel of a 9 rating.
7	One or more undesirable characteristics can be found, but take concentration to find. (Examples are light surge or off idle flatness.)
6	The undesirable characteristic(s) are definitely noticeable, but not objectionable. (Examples are moderate surge, sags, and/or stumbles.)
5	The undesirable characteristic(s) are obvious and somewhat irritating and may result in a customer complaint. (Examples are medium surge, sags, and/or stumbles.)
4	Disturbing: An engine operation exists which is disturbing to the driver but is not serious enough to undermine the driver's confidence in the car's ability to continue running. (Examples are heavy surge, sags, and/or stumbles.) The customer would definitely seek corrective action.
3	A condition exists which undermines the driver's confidence in the car's ability to perform reliably at all times. (Examples are severe surge, sags and/or stumbles.)
2	A failure of the engine to continue running. (Examples are passouts that could be driven around or decel dieouts which occur while the vehicle is still in motion.)
1	A condition exists which could cause unpredictable driveability during normal operations. This rating would generally apply to moving passouts which cannot be driven around.

Table 5

PERFORMANCE

NO.	DEFINITION
9	The vehicle would have an exceptionally good responsive feel under all conditions.
8	Vehicle's performance is above average. Driver feels that the car has better performance than he expected.
7	Driver feels vehicle's performance is what it should be.
6	Satisfactory: Driver feels vehicle does not perform as well as he thought it would but he would not return the car for a performance complaint.
5	Borderline: Vehicle does not perform as well as driver thought it would. A customer may complain and ask that the vehicle be checked for proper operation (e.g., poor passing and acceleration capability under normal conditions).
4	Disturbing: An engine performance problem exists which is disturbing but is not serious enough to undermine the driver's confidence in the car's ability to pass another vehicle. A customer would be unhappy with product and require that the condition be corrected.
3	Lack of Confidence: Vehicle performance is so weak that the driver lacks the confidence required to try a passing maneuver.
2	Vehicle performance is so weak that the driver is reluctant to operate vehicle on public roads.
1	Undefined

Table 6

GLOSSARY OF DRIVEABILITY TERMS

After Running:
Engine continues to run after the ignition is turned off. Sometimes referred to as "dieseling" although this is not an accurate description of the condition and After-Running is preferred.

Backfire:
Combustion of the unburned air-fuel mixture which takes place in the exhaust system rather than in the combustion chamber. Resulting combustion pressure exits through the muffler and tailpipe.

Detonation or Spark Knock:
Engine "knock" that occurs only when accelerating. Usually associated with medium to heavy throttle acceleration or lugging at relatively low speeds especially with a manual transmission. However, it may occur in higher speed ranges under heavy load conditions. Caused by advance timing or low octane fuel.

Die-Out:
An engine stall with the throttle in the closed position irrespective or vehicle movement.

Flat Spot:
Lack of normal acceleration or response to throttle opening ... no loss of power, but no increase. Engine does not miss or die as in the case of Cut-Out or Pass-Out.

Hesitation:
Momentary lack of throttle response at some car speed.

Miss:
Short for misfires or failure to ignite the mixture in one or more cylinders. This condition may be intermittent or continuous on one or more cylinders.

Pass-Out:
An engine stall with throttle movement irrespective of vehicle movement.

Pop-Back:
Mixture in the intake manifold is ignited and the resulting combustion takes place outside of the combustion chamber so that it may "pop-back" through the carburetor.

Sag:
Lack of normal acceleration or response to the initial movement of the throttle followed almost immediately by normal response. A sag is severe hesitation.

Stumble:
Lack or response to initial movement of the throttle from a standstill.

Table 6 (Cont'd.)

Surge:
Engine speed increases and decreases slightly but perceptibly in spite of the fact that the driver has not changed throttle position.

Vapour Lock:
Slow hot start or won't start condition caused by vaporization of the fuel in the fuel lines. As a result, liquid fuel is not delivered to the carburetor.

ATTACHMENT 7

TO START ENGINE

COLD ENGINE OR FIRST START OF DAY (Above 0°F)

Press accelerator pedal to floor and slowly remove foot from pedal. Turn key to "START" and hold until engine runs, then release key.

If engine speed seems excessive, lightly depress and release pedal five seconds after start.

WARM ENGINE

Press accelerator pedal 1/3 of the way down and hold. Turn key to "START" and hold until engine runs, then release key and pedal.

EXTREMELY COLD ENGINE (Below 0°F)

Press accelerator pedal to the floor and release. Then hold pedal 1/3 of the way down. Turn key to "START" and hold until engine runs, then release key and pedal.

IF ENGINE FAILS TO START

If engine fails to start after cranking 15 seconds, stop cranking, and after one minute repeat the proper procedure.

If repeated starting attempts are unsuccessful, the engine may be "loaded" with gasoline. In this instance, the following procedure should be followed:

1. Press the accelerator pedal all the way to the floor and hold firmly. DO NOT PUMP THE PEDAL.
2. Turn key to "START".
3. Release key when engine starts.
4. Release pedal gradually as engine speeds up.

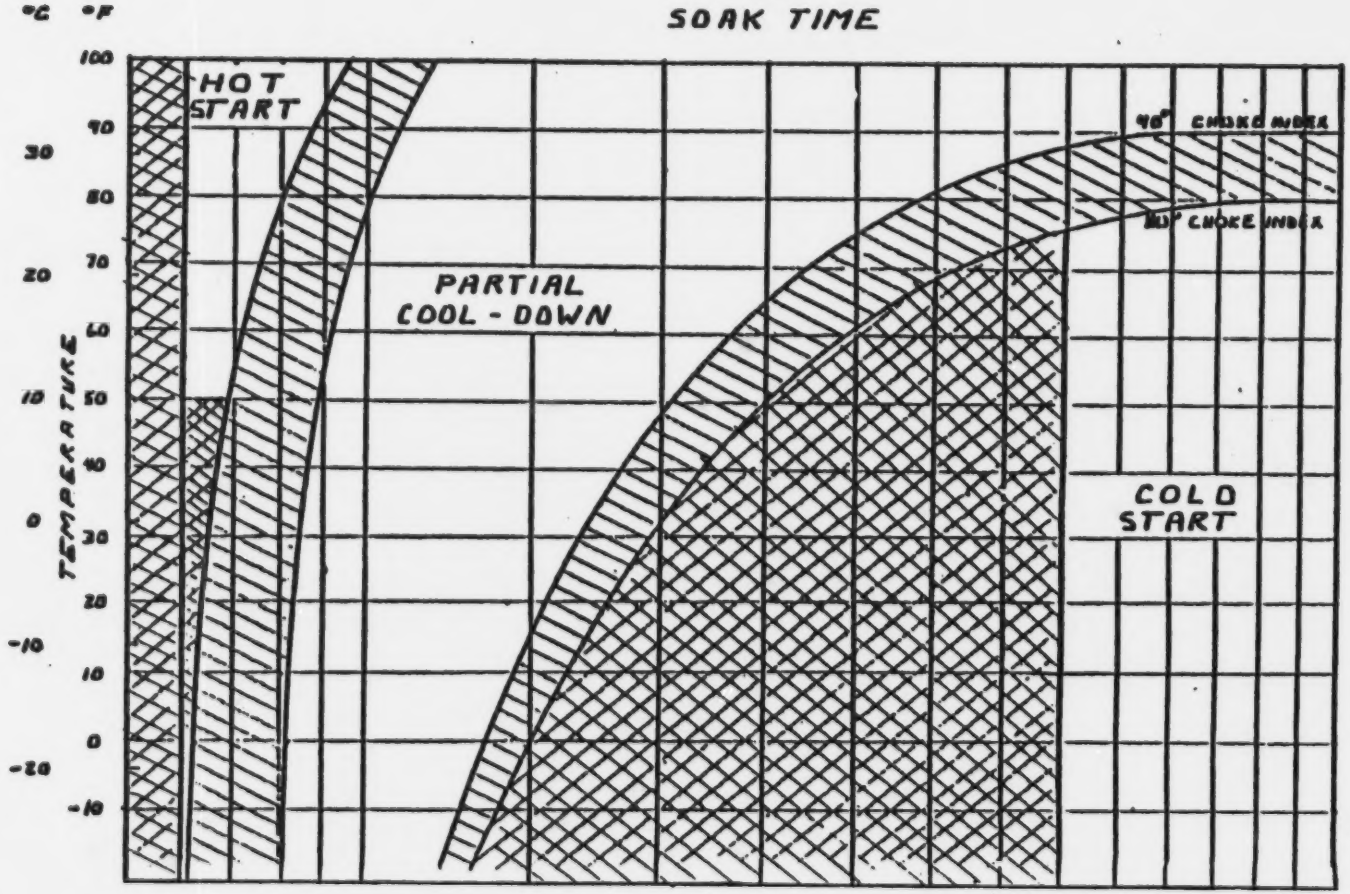
CAUTION: Do not hold key in "START" position longer than 15 seconds at a time.

CAUTION: Cold start difficulty can result if ignition is left in "ON" position when engine is not running.

ATTACHMENT V111

DRIVEABILITY COOL-DOWN RATE

AMBIENT TEMPERATURE VS. SOAK TIME



APPENDIX C

CHRYSLER CANADA LTD. - FEDERAL GOVERNMENT PROPANE VEHICLE DEMONSTRATION PROGRAM

— TEST PLAN FOR FIELD DEMONSTRATION —

Chrysler Canada Product Engineering will provide the following to the Regional Offices:

- propane demonstration vehicles per attached schedule.
- short propane seminar in Windsor on propane vehicle development, operation and service.
- continuing technical information and advice throughout the program.
- propane demonstration vehicle participant information packets which include:
  - program introductory letter to fleet owner/manager
  - driver questionnaires
  - owner/manager questionnaires
  - list of metered propane distributors in the region
  - vehicle fuel, scheduled maintenance and service log book
  - folders for above material

Chrysler Canada Regional Offices will provide to fleet participants:

- propane demonstration vehicles as per schedule developed by the region.
- propane demonstration vehicle participant information packet.
- general program information and guidance.

During the 52-week demonstration period, the following guidelines will be followed:

1. The Regional Offices will control and schedule their vehicles with interested fleet accounts for evaluation, and will ensure that vehicle fuel, scheduled maintenance and service log books and survey questionnaires are promptly filled out and returned to Product Engineering after each account demonstration.

2. Priority will be given to federal government requests for use of the vehicles.

3. Reasonable access to the vehicles will be granted Product Engineering for required testing.

4. Service and repairs will be handled by the Regional Offices through their dealers.

Chrysler Canada's Regional Offices will provide Product Engineering with:

- brief, quarterly reports (first due on Dec. 31, 1981 and then March 31, 1982, June 30, 1982 and Sept. 30, 1982) summarizing the progress and effectiveness of the demonstration program in their region to date, including comments on any further propane vehicle design requirements. It should also include the regional office assessment of any existing conditions or problems that tend to inhibit propane vehicle sales in their region.

- estimates, at the end of the demonstration period, of propane vehicle potential sales (by vehicle type and engine) that can be expected in their region for each of the model years 1983 to 1986 inclusive.

81-07-07

PROPANE-FUELED DEMONSTRATION VEHICLES

	B250 Commuter Vans with 5.2 L Engine	Panel Vans	D250 Pickup Trucks	Conventional Taxis	Front-Wheel-Drive Cars with 2.2 L Engine
Ontario Regional Sales Office		1 - 6-cyl. Auto. Trans.	1 - 6-cyl. Man. Trans.	1 - 6-cyl. Auto. Trans.	
Quebec Regional Sales Office		1 - 6-cyl. Man. Trans.	1 - 6-cyl. Auto. Trans.	1 - 6-cyl. Auto. Trans.	
Alberta & British Columbia Regional Sales Offices		1 - 8-cyl. Auto. Trans.	1 - 8-cyl. Auto. Trans.	1 - 8-cyl. Auto. Trans.	
Windsor Head Office	3 - 8-cyl. Auto. Trans.				1 - 4-cyl. Man. Trans. 1 - 4-cyl. Auto. Trans

Notes:

. Head Office vehicles will be made available to Regional Offices on a part-time, as-required basis.

. Selected vehicles will be scheduled to government departments for their test and evaluation as required.

81-06-30
/bj

APPENDIX D

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: COMMUTER VAN - 8 CYL A/T

VEHICLE NO: 2B5WB31P5BK234274

DATES		LOCATION	METRAGE
FROM	TO		
81-08-07	82-08-31	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 HENRY KRUEGER. TEL. 519-252-3631	30957

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: COMMUTER VAN - 8 CYL A/T

VEHICLE NO: 2B5WB31P7BK234275

DATES		LOCATION	METRAGE
FROM	TO		
81-08-07	82-08-31	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 VIC TIESSEN. TEL. 519-252-3631	38558

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: COMMUTER VAN - 8 CYL A/T

VEHICLE NO: 2B5WB31P9BK234276

DATES		LOCATION	METRAGE
FROM	TO		
81-08-07	82-07-31	CHRYLSER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 HENRY SZYMKIEWICZ. TEL. 519-252-3651	29635

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PANEL VAN - 6 CYL M/T

VEHICLE NO: 2B7HB23E9BK265422

DATES		LOCATION	METRAGE
FROM	TO		
81-10-01	81-12-13	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4880	2200
81-12-14	81-12-23	TRANSPORT CANADA MOTOR VEHICLE TEST CENTRE P.O. BOX 285 BLAINVILLE, QUEBEC PATRICK CROWLEY. TEL. 514-430-7981	2750
81-12-24	82-01-04	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND. TEL. 514-697-4880	3350
82-01-15	82-02-24	GAZ METROPOLITAIN 1717 DU HAVRE STREET MONTREAL, QUEBEC JEAN DUPUIS. TEL. 514-527-8455	6300
82-03-25	82-04-24	QUEBEC TELEPHONE 281 BOULEVARDE RENE LEPAGE RIMOUSKI, QUEBEC, G5L 7E4 JEAN PAUL BANVILLE. TEL. 418-722-5292	11848
82-04-25	82-05-01	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4800	12400
82-05-01	82-05-18	CONTINENTAL AIR FREIGHT LTD. DORVAL AIRPORT DORVAL, QUEBEC TEL. 514-636-4290	13500

82-08-18	82-08-27	TEINTEINTURERIE LAPOCATIERE QUEBEC, CHARLES AUGUSTE BOUCHARD	15725
82-08-28	82-08-31	BOULANGERIE LECLARE LAPOCATIERE, QUEBEC J.P. LECLARE	16400
82-09-07	82-09-13	ROLAND ET FRERES LTD. ST-PACOME, QUEBEC JEAN CLAUDE LEVESQUE	17400
82-09-14	82-09-30	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4800	17600

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PANEL VAN - 6 CYL A/T

VEHICLE NO: 2B7HB23E6BK265443

DATES		LOCATION	METRAGE
FROM	TO		
81-10-01	81-10-14	CHRYSLER CANADA LTD. 4500 MISSISSAUGA ROAD MISSISSAUGA, ONTARIO, L5N 1A8 EUGENE PROKOPCHUK, TEL. 416-826-1042	1280
81-10-14	81-11-30	WESTINGHOUSE CANADA INC. P.O. BOX 510 HAMILTON, ONTARIO, L8N 3K2 A.V. MARSHALL. TEL. 416-528-8811	3462
81-12-02	81-12-22	COORSH & SONS 896 LAKESHORE RD. E. PORT CREDIT, ONTARIO, L5E 1E1 BOB BOWMAN. TEL. 416-278-5121	6400
81-12-23	82-01-04	CIMCO LTD. 65 VILLIERS STREET TORONTO, ONTARIO, M5A 1B2 DOUG SCHENIMAN	6855
82-01-07	82-01-21	PLANET PROPANE LTD. 24 HORTON STREET LONDON, ONTARIO, N6A 5J4 WAYNE VIZNOWSKY, TEL. 519-432-2207	7500
82-01-22	82-02-23	CHRYSLER CANADA LTD. 4500 MISSISSAUGA ROAD MISSISSAUGA, ONTARIO, L5N 1A8 EUGENE PROKOPCHUK, TEL. 416-826-1042	8500
82-02-24	82-03-23	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS, TEL. 519-252-3651	8700

82-03-29	82-05-11	ONTARIO MINISTRY OF TRANSPORTATION AND COMMUNICATIONS 1201 WILSON AVENUE ROOM 143, CENTRAL BUILDING DOWNSVIEW, ONTARIO, M3M 1J8 BOB HOPKINSON, TEL. 416-248-3841	11487
82-05-13	82-05-17	I.C.G. CANADIAN PROPANE LTD. 112 BASALTIC ROAD MAPLE, ONTARIO, L0J 1B0 G. GIROUARD, TEL. 416-677-0770	12100
82-05-19	82-06-28	SIMPSONS SEARS LTD. 800 WARDEN AVENUE SCARBOROUGH, ONTARIO, M1L 4P7 SYD DAWSON, TEL.	15547
82-06-30	82-07-28	CHUBB INDUSTRIES 263 QUEEN STREET EAST BRAMPTON, ONTARIO, L6W 2C1 DOREEN ANNATTE, TEL. 416-451-3240	18705
82-07-29	82-08-17	SEARS (DIVISION OF REECHHOLD LTD.) 220 NORELCO DRIVE WESTON ONTARIO, M9L 1S3 PETER RINGLER, TEL. 416-244-5111	19200
82-08-18	82-09-30	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR ONTARIO, N9A 4H6 BRIAN GRIFFITHS, TEL. 519-252-3651	19200

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PANEL VAN - 8 CYL A/T

VEHICLE NO: 2B7HB23P0BK265584

DATES		LOCATION	METRAGE
FROM	TO		
81-10-01	81-11-01	CHRYSLER CANADA LTD. NO. 2 HIGHWAY, BOX 670 RED DEER, ALBERTA, T4N 5G9 ART WEGNER, TEL. 403-346-4131	1480
81-11-11	82-01-05	ALBERTA GOVERNMENT TELEPHONE 417, 10063 JASPER AVENUE EDMONTON, ALBERTA, T5J 3B1 BRUCE THOMPSON, TEL. 403-425-4890	3487
82-02-09	82-03-20	CITY OF CALGARY 735-25 AVENUE S.E. CALGARY, ALBERTA, T2C 1R5 JIM SHEARER, TEL. 403-268-4048	4216
82-03-22	82-05-12	EAST SIDE DODGE CHRYSLER 815 36 STREET N.E. CALGARY, ALBERTA, T2A 4W3 BILL KRINE, TEL. 403-273-4313	4657
82-05-13	82-06-30	CITY OF EDMONTON 10565-105 ST. EDMONTON, ALBERTA, T5H 2W8 ERIC SCHARFENBERG, TEL.	6509
82-06-30	82-09-30	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS, TEL. 519-252-3651	7500

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PICK-UP TRUCK - 6 CYL M/T

VEHICLE NO: 1B7HD14E8BS170679

DATES FROM	DATES TO	LOCATION	METRAGE
81-10-03	82-03-09	CHRYSLER CANADA LTD. 4500 MISSISSAUGA ROAD, MISSISSAUGA, ONTARIO, L5N 1A8. JOHN LEVASSEUR. TEL. 416-826-1042	3500
82-03-10	82-03-29	ONTARIO MINISTRY OF TRANSPORTATION AND COMMUNICATIONS 1201 WILSON AVENUE ROOM 143, CENTRAL BUILDING DOWNSVIEW, ONTARIO, M3M 1J8 BOB HOPKINSON, TEL. 416-248-3841	6687
82-03-31	82-05-12	MUNICIPALITY OF HAMILTON WESTWORTH 71 MAIN STREET WEST HAMILTON ONTARIO, L8N 3T4 BOL MULHOLLAND, TEL. 416-526-4479	8975
82-05-12	-	CHRYSLER CANADA LTD. 4500 MISSISSAUGA ROAD MISSISSAUGA, ONTARIO, L5N 1A8 JOHN LEVASSEUR, TEL. 416-826-1042	9261
82-08-10	82-09-01	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR ONTARIO, N9A 4H6	11760

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PICK-UP TRUCK - 6 CYL A/T

VEHICLE NO: 1B7HD24E7BS170131

DATES FROM	DATES TO	LOCATION	METRAGE
81-10-01	81-12-17	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND. TEL. 514-697-4880	2200
81-12-18	81-12-22	TRANSPORT CANADA MONTREAL INTERNATIONAL AIRPORT BOX 5000 DORVAL, QUEBEC, H4Y 1B9 ANDRE BIRON. TEL. 514-636-3251	2750
81-12-23	82-02-08	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND. TEL. 514-697-4880	3300
82-02-09	82-03-23	TRANSPORT CANADA DORVAL AIRPORT FACILTIES DORVAL, QUEBEC MARCEL LEBEL. TEL. 514-636-3375	4450
82-03-30	82-04-02	QUEBEC HYDRO 75 DORCHESTER WEST MONTREAL, QUEBEC PIERRE MOQUIN. TEL. 514-289-4053	4900
82-04-02	82-04-15	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4880	5502
82-04-15	82-05-01	QUEBEC HYDRO 75 DORCHESTER W. MONTREA, QUEBEC PIERRE MOQUIN, TEL. 514-289-4053	6178
82-05-11	82-06-21	CITY OF LONGUEUIL 777 RUE D'AUVERGNT QUEBEC PIERRE GIRARD, 514-651-1300	7253

82-07-06	82-07-20	CITY OF POINTE CLAIRE 50 TERRA COTTA POINTE CLAIRE, QUEBEC ISADORE CORRIVEAU, TEL. 514-697-0770	7600
82-07-06	82-07-20	CITY OF POINTE CLAIRE 451 ST. JEAN POINTE CLAIRE, QUEBEC	7821
82-07-21	82-09-30	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4880	8140

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PICK-UP TRUCK - 8 CYL A/T

VEHICLE NO: 1B7KD26P8BS164097

DATES		LOCATION	METRAGE
FROM	TO		
81-10-08	81-10-16	CHRYSLER CANADA LTD. NO.2 HIGHWAY, BOX 670 RED DEER, ALBERTA, T4N 5G9 ART WEGNER. TEL. 403-346-4151	2300
81-11-10	82-02-10	ALBERTA GOVERNMENT TELEPHONE 417, 10065 JASPER AVENUE EDMONTON, ABERTA, T5J 3B1 DOC VANLEUKEN. TEL. 403-425-4890	6000
82-02-15	82-02-22	ICG UTILITIES (PLAINS WESTERN LTD) BOX 800 LEDUC, ALBERTA, T9E 4N3 PETER WHALLEY, TEL. 403-986-5215	7500
82-03-12	82-03-17	JUGGERNAUT SYSTEMS LTD. 6770 65 AVENUE RED DEER, ALBERTA, T4P 1A5 JOHN COUSINS, TEL. 403-343-3110	8689
82-03-19	82-03-22	BOUCHARD ELECTRIC BOX 980 RED DEER, ALBERTA, T4N 5H3 LYNN PACKARD, TEL. 403-343-1880	9226
82-03-25	82-03-31	ALBERTA GAS ETHYLENE (NOVA) GENERAL DELIVERY JOFFRE, ALBERTA RICK HUTCHINS, TEL. 403-342-8789	9905

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: CONVENTIONAL TAXI - 6 CYL A/T

VEHICLE NO: 1P3BM36H7BB171219

DATES FROM	DATES TO	LOCATION	METRAGE
81-07-01	81-07-28	DEPARTMENT OF NATIONAL DEFENCE 101 COLONEL BY DRIVE OTTAWA, ONTARIO, K1A 0K2 MAJOR C.A. BUTTERFIELD. TEL. 613-996-0976	2643
81-08-01	81-09-15	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 519-252-3651	3700
81-10-25	81-11-29	CHRYSLER CANADA LTD. 4500 MISSISSAUGA ROAD MISSISSAUGA, ONTARIO, L5N 1A8 JOHN LEVASSEUR. TEL. 416-826-1042	4000
81-11-30	81-12-04	WESTINGHOUSE CANADA INC. P.O. BOX 510 HAMILTON, ONTARIO, L8N 3K2 H. MARSHALL. TEL. 416-528-8811	5293
81-12-05	82-01-06	ROBIN HOOD MULTIFOODS INC. 243 CONSUMERS ROAD WILLOWDALE, ONTARIO, M2J 4R4 BRUCE MCLEOD. TEL. 416-496-1515	6936
82-01-16	82-13-01	METROPOLITAN TORONTO POLICE 590 JARVIS STREET TORONTO, ONTARIO, M4Y 2J5 A. GIBB, TEL. 416-967-2081	8464
82-03-06	82-06-25	ICG CANADIAN PROPANE LTD. 112 BASALTIC ROAD MAPLE, ONTARIO, L0J 1B0 GERRY GIROUARD, TEL. 416-667-0770	17824

82-05-06	82-05-07	ITT GRINNELL DIVISION OF ITT INDUSTRIES 10 N. QUEEN STREET TORONTO, ONTARIO, M8Z 2C5 CHARLEY SHORE, TEL. 416-251-4171	17905
82-05-18	82-05-18	CANADIAN LINEN SUPPLY CO. LTD. 24 ATOMIC AVENUE ETOBICOKE, ONTARIO, M8Z 5L2 WIFRED WATSON, TEL. 416-251-2251	17915
82-05-18	82-05-19	OWENS CONSTRUCTION LTD. 103 PHYLLIS STREET TORONTO, ONTARIO, M1M 1Y2 MICHAEL OWENS, TEL. 416-261-4129	17948
82-05-20	82-05-21	TRANSPO PARTS CO. LTD. 140 MILVAN DRIVE REXDALE, ONTARIO, M9L 1Z9 LARRY MEROVITZ, TEL. 416-745-9560	17997
82-05-30	82-06-01	BLACKWOOD HODGE 10 SUNTRACT STREET TORONTO, ONTARIO, M9N 3M9 ART GRIFFITH, TEL. 416-244-2531	18026
82-06-07	82-06-07	LANZAROTTA WHOLESALE GROCERS LTD. 711 RIVERMEDE DRIVE THORNHILL, ONTARIO JIM GENARO, 416-669-9814	18145
82-06-07	82-06-08	TOLEDO SCALE 5220 CREEKBANK ROAD MISSISSAUGA, ONTARIO, L4W 2G2 BILL MURPHY, TEL. 416-625-8112	18276
82-06-14	82-06-15	C P RAIL UNION STATION FRONT STREET TORONTO, ONTARIO, M5E 1B3 LYNN SAWCHUK, TEL.	18325
82-06-20	82-06-21	INTER CAB CO. LTD. 1085 FEWSTER STREET MISSISSAUGA, ONTARIO, L4W 1A2 HURLEY, TEL. 416-967-1212	18372
82-06-23	82-06-24	GEORGE BROWN COLLEGE 100 CHERRY STREET TORONTO, ONTARIO, M5A 3L1 BOB FARQUESON	18626

82-06-30	82-08-10	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS, TEL. 252-3651	18797
82-08-10	82-08-17	CORBY DISTILLERY LTD. 45 SHEPHERD AVE E. WILLOWDALE ONTARIO, M2N 5W9 KEITH RINTOUL, TEL. 416-226-6940	19800
82-08-20	82-08-30	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR ONTARIO, N9A 4H6 BRIAN GRIFFITHS, TEL. 252-3651	20331

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: CONVENTIONAL TAXI - 6 CYL A/T

VEHICLE NO: 1P3BM36H8BG171486

DATES		LOCATION	METRAGE
FROM	TO		
81-07-01	81-07-28	DEPARTMENT OF NATIONAL DEFENCE 101 COLONEL BY DRIVE OTTAWA, ONTARIO, K1A 0K2 MAJOR C.A. BUTTERFIELD. TEL. 613-996-0976	3449
81-08-01	81-09-15	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 519-252-3651	5017
81-10-05	81-10-21	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND. TEL. 514-697-4880	5186
81-10-22	81-10-29	TRANSPORT CANADA FACILITIES BRANCH TRANSPORT CANADA BLDG. OTTAWA, ONTARIO, K1A 0N8 RON BURKILL. TEL. 613-995-7994	5837
81-11-19	81-12-06	TRANSPORT CANADA TRANSPORTATION DEVELOPMENT CENTRE 1000 SHERBROOKE ST. WEST MONTREAL, QUEBEC, H3A 2R3 MICHEL TAPIERO. TEL. 514-283-7682	7692
81-12-19	82-02-15	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 514-252-3651	8623

82-02-15	82-03-20	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND. TEL. 514-697-4880	11166
82-03-20	82-03-22	PLANTE AUTOMOBILES 671 MARIE VICTORIA ST. PIERRE DESOREL, QUEBEC J3P 5K4 CONSTANT PLANTE. TEL. 514-742-4577	11500
82-03-22	82-03-27	ALFRED CAISSE INCORPORATED 151 ROY STREET, SOREL, QUEBEC MICHEL CAISSE	11730
82-03-27	82-03-31	CITE DE SOREL 71 RUE CHARLOTTE SOREL, QUEBEC DORUIS FOREST	12314
82-04-01	82-04-09	CITE DE TRACY 3025 BOULEVARD DE LA MAIRIE TRACY, QUEBEC CHARLES VAILLAINCOURT	12915
82-04-10	82-05-04	CHRYSLER CANADA LTD. 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4880	13750
82-05-05	82-05-18	RCMP 250 TREMBLAY ROAD OTTAWA, ONTARIO, SGT. F. PINNOCK, TEL. 613-993-3180	14560
82-05-18	82-05-31	TRANSPORT CANADA TRANSPORTATION DEVELOPMENT CENTRE 1000 SHERBROOKE ST. W. MONTREAL, QUEBEC, H3A 2R3 MICHEL TAPIERO, TEL. 514-283-7682	14796
82-05-31	82-06-09	CHRYSLER CANADA 3000 TRANS CANADA HIGHWAY BOX 550 POINTE CLAIRE, QUEBEC, H9R 4P6 BOB BRIAND, TEL. 514-697-4880	15279

82-06-09	82-07-15	DEPT. OF SUPPLY AND SERVICE TRANSPORT AND ENERGY PRODUCT CENTRE ROOM 781, PLACE DU PORTAGE 11 LAURIER, HULL QUEBEC L. SCADSEAGNETTI, TEL. 819-994-0507	17420
82-07-16	82-08-30	CHRYSLER CANADA CHRYSLER CENTRE WINDSOR ONTARIO. N9A 4H6 BRIAN GRIFFITHS, TEL. 519-252-3631	17832

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: CONVENTIONAL TAXI - 8 CYL A/T

VEHICLE NO: 1P3BM36L0BG171485

DATES FROM	DATES TO	LOCATION	METRAGE
81-07-01	81-07-28	DEPARTMENT OF NATIONAL DEFENCE 101 COLONEL BY DRIVE OTTAWA, ONTARIO, K1A 0K2. MAJOR C.A. BUTTERFIELD. TEL. 613-996-0976	2103
81-08-01	81-09-01	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 519-252-3651	3076
81-10-12	81-11-10	RCMP (K DIVISION) 11140, 109 STREET EDMONTON, ALBERTA, T5G 2T4 AL HASKINS. TEL. 403-479-9330	7010
81-11-17	82-02-10	ALBERTA GOVERNMENT TELEPHONE 417, 10065 JASPER AVENUE EDMONTON, ALBERTA, T5J 3B1 BRUCE THOMPSON, TEL. 403-425-4890	10842
82-02-22	82-02-26	ICG CANADIAN PROPANE LTD. 1100 BRODIE BUILDING 630-6 AVENUE S.W. CALGARY, ALBERTA, T2P 0S9 ALBERT MARTINEAU, TEL. 403-269-6130	11311
82-03-22	82-03-31	CITY OF CALGARY POLICE DEPT. 316-7 AVENUE S.E. P.O.BOX 2100 CALGARY, ALBERTA, T2P 2M5 STAN GROVE, TEL. 403-268-5916	13286
82-04-01	82-04-22	RCMP (K DIVISION) 109 STREET EDMONTON, ALBERTA, T5J 5N1 AL HASKINS, TEL. 403-479-9355	15586
82-04-23	82-05-14	CITY OF GALGARY POLICE DEPT. 316-7 AVE., S.W. CALGARY, ALBERTA, T2P 2M5 STAN GROVE, TEL. 403-268-5916	16962

82-05-20	82-06-20	CITY OF EDMONTON 10565-105 STREET EDMONTON, ALBERTA, T5H 2W8 ERIC SCHARFENBERG, TEL.	18543
82-06-22	82-08-30	CROSS TOWN MOTOR-CITY 104 AVE., 120 STREET EDMONTON, ALBERTA, T5G 2J6 BRUCE COWEN, TEL. 403-488-4881	18600
82-08-30	82-08-31	CITY CAB CO. 10315-78 AVE. EDMONTON ALBERTA, T6E 1N8 BILL BENNET, TEL. 403-432-5151	18847

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: FRONT WHEEL DRIVE CAR - 4 CYL A/T

VEHICLE NO: 1P3BK49B9BF239416

DATES		LOCATION	METRAGE
FROM	TO		
81-12-01	82-05-13	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 519-252-3651	4603
82-05-13	82-09-15	PUROLATOR 450 E.C. ROW SERVICE ROAD WINDSOR, ONTARIO, N9A 6J3 BILL BLAKE, TEL. 519-945-2392	15114
82-09-15	82-09-30	CHRYSLER CANADA CHRYSLER CENTRE WINDSOR ONT., N9A 4H6 BRIAN GRIFFITHS, TEL. 252-3651	30236

CHRYSLER CANADA - TRANSPORT CANADA

PROPANE VEHICLE DEMONSTRATION PROGRAM

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: FRONT WHEEL DRIVE CAR - 4 CYL M/T

VEHICLE NO: 1P3BK43B7BF239415

DATES		LOCATION	METRAGE
FROM	TO		
81-12-01	82-05-12	CHRYSLER CANADA LTD. CHRYSLER CENTRE WINDSOR, ONTARIO, N9A 4H6 BRIAN GRIFFITHS. TEL. 519-252-3631	7913
82-05-12	82-09-15	BDC LTD. 960 HANNA E. WINDSOR, ONTARIO, N8X 2P3 PAUL SMITH, TEL. 519-258-7200	17696
82-09-15	82-09-30	CHRYSLER CANADA CHRYSLER CENTRE WINDSOR ONT., N9A 4H6 BRIAN GRIFFITHS, TEL. 252-3631	22000

CHRYSLER CANADA

NON CONTRACT PROPANE DEMONSTRATION VEHICLE

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: VAN - 8 CYL A/T

VEHICLE NO: 2B7HB2325CK148134

DATES		LOCATION	METRAGE
FROM	TO		
82-04-19	82-04-29	BC HYDRO 970 BURRARD STREET VANCOUVER, BRITISH COLUMBIA, V6Z 1Y3 TEL. 604-663-2212	1035
82-05-03	82-05-14	BC TELEPHONE 3777 KINGSWAY AVENUE BURNABY, BRITISH COLUMBIA, V5H 3Z7 B. HOLLINGSHEAD, TEL. 604-432-2151	1265
82-05-17	82-06-04	CITY NATIONAL LEASING SUITE 2, 5334 LOUGHEED HIGHWAY BURNABY, BRITISH COLUMBIA, V5B 2Z8 F. BABICHUCK, TEL. 604-294-5257	1775
82-06-07	82-06-18	HUSKY OIL LIMITED 750 WEST 70th STREET VANCOUVER, BRITISH COLUMBIA, V6P 2X4 TEL. 604-327-7111	2692
82-06-21	82-07-08	MOHAWK OIL 6400 ROBERTS STREET BURNABY, BRITISH COLUMBIA, V5G 4G2 TEL. 604-299-7244	3100
82-07-13	82-08-12	LOMMIS COURIER SERVICE 3057 GRANDORIEU HWY. VANCOUVER B.C., V5M 2E4 E. KANALLES, TEL. 604-438-7311	6924
82-08-18	82-08-16	CABLE WEST 1471 DEMBERTON AVE. VANCOUVER B.C., V7P 2R9 JOHN MENSINK, TEL. 604-985-2151	7365
82-08-30	82-09-08	CANADIAN RED CROSS 4750 OAK ST. VANCOUVER B.C., V6H 2N9 GEORGE ROGERS, TEL. 604-879-7551	7700
82-09-10	82-09-30	ACKLANDS LTD. 8651 EAST LAKE DRIVE BURNABY B.C., V5A 3X4 JOHN TREDENICK, TEL. 604-421-2311	9000

CHRYSLER CANADA

NON CONTRACT PROPANE DEMONSTRATION VEHICLE

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PICKUP - 6 CYL A/T

VEHICLE NO: 1B7GD14Y8CS236123

DATES		LOCATION	METRAGE
FROM	TO		
82-04-23	82-05-13	MARITIME TELEPHONE AND TELEGRAPH PO BOX 880 3601 JOSEPH HOWE AVENUE HALIFAX, NOVA SCOTIA, B3J 2W3 R. WILSON, TEL. 902-454-1363	2300
82-05-14	82-05-26	NOVA SCOTIA POWER CORPORATION SCOTIA SQUARE PO BOX 910 HALIFAX, NOVA SCOTIA, B3J 2W5 C. LINDSAY, TEL. 902-424-5769	2750
82-05-26	82-06-03	CITY OF HALIFAX PO BOX 1749 HALIFAX, NOVA SCOTIA, B3J 3A5 PETER MESSENGER, TEL. 902-426-6484	3850
82-06-17	82-06-23	HOYT MOVING AND STORAGE MILLS DRIVE PROSPECT ROAD HALIFAX COUNTY, NOVA SCOTIA, CLIFFORD HOYT, TEL. 902-852-4002	4500
82-06-25	82-07-06	NEW BRUNSWICK TELEPHONE CO. LTD. 133 WOODARD AVENUE ST JOHN, NEW BRUNSWICK, E2K 1Z9 RAY JOHNSON, TEL. 506-693-6142	5100
82-07-08	82-07-27	NEW BRUNSWICK DEPT OF FORESTRY 498 YORK STREET FREDERICTON, NEW BRUNSWICK, E3B 3P7 A. FULCHER, TEL. 506-453-2356	6600
82-07-27	82-08-16	NEW BRUNSWICK DEPT. OF HIGHWAYS FREDERICKTON N.B., MR. ARNOLD	7200
82-08-17	82-08-30	NEW BRUNSWICK ELECTRIC POWER FREDERICKTON N.B. MR.SULLIVAN, TEL. 506-453-4493	7800

CHRYSLER CANADA

NON CONTRACT PROPANE DEMONSTRATION VEHICLE

- VEHICLE LOCATION RECORD -

VEHICLE TYPE: PICKUP - 6 CYL A/T

VEHICLE NO: 1B7HD14Y1CS244231

DATES FROM	DATES TO	LOCATION	METRAGE
82-05-10	82-05-14	CIGAS PRODUCTS LTD. 1248 WILKES AVENUE WINNIPEG, MANITOBA, R3N 0P3 L. OLSON, TEL. 204-453-4939	250
82-05-19	82-05-31	MANITOBA TELEPHONE SYSTEM 100 - 1730 McGILLIVRY PO BOX 6666 WINNIPEG, MANITOBA, R3C 3V6 KEN RANSON, TEL.	467
82-06-03	82-06-18	MANITOBA HYDRO 700 HARROW STREET WINNIPEG, MANITOBA, R3C 2P4 EMIL KIZIAK, TEL. 474-3702	1525
82-06-18	82-07-05	DUCKS UNLIMITED (CANADA) 1190 WAVERLY BLVD. WINNIPEG MAN., R3T 2E2 BOB LAIDIER; TEL. 477-1760	2505
82-07-14	82-08-03	WILLSON OFFICE SPECIALTY LTD. 1550 WILLSON PLACE WINNIPEG MAN., R3T 0Y4 GORDON ZINKOWSKI; TEL. 284-5100	3231
82-08-04	82-08-09	CITY OF WINNIPEG 220 TECUMSEH ST. WINNIPEG MAN., R2E 2B2 JOHN WILSBECH; TEL. 786-8080	4552
82-08-09	82-08-25	CARGILL GRAIN CO. LTD. THE CARGILL BUILDING 300-240 GRAHAM AVE. WINNIPEG MAN., R3C 4C5 BOB GERMAIN; TEL. 947-0141	5065
82-09-01	82-09-30	CANADA POST 266 GRAHAM AVE WINNIPEG MANITOBA, R3C 0K0 JOHN KANDIA, TEL. 949-4957	6300

PICK-UP TRUCK	231	CONTINUED
82-09-15 82-09-30	R.C.M.P. 1091 PORTAGE AVE. WINNIPEG MANITOBA CORP. DOUG COLTART, TEL. 949-5461	7500

APPENDIX E

LOWER HEATING VALUES AND LOWER HEATING VALUE RATIOS

LOWER HEATING VALUES

Component	Composition by Volume	Liquid Density @15 C kg/L	(lb/Imp Gal)	Lower Heating Value kJ/kg	(Btu/lb)
Propane	92.5%	0.507	(5.08)	46325	(19916) *
Butane	2.5%	0.582	(5.63)	45690	(19643) *
Propylene	5 %	0.521	(5.22)	45801	(19691)
Grade 1#	100 %	0.510	(5.11)	46240	(19880)

FUEL	S.G. @ 15 C	Lower Heating Value kJ/kg	(Btu/lb)	kJ/L	(Btu/Imp Gal)
Grade 1 Propane		46240	(19880)	23580	(101600)
Indolene		44510	(19136)	33020	(142280)
Gasoline	0.739	43960	(18900) *	32490	(139990)
	0.702	44240	(19020) *	31060	(133820)
	(typical) **			31580	(136070)

LOWER HEATING VALUE RATIOS

SAMPLE CALCULATIONS

$$\text{Lower Heating Value Factor} = \frac{\text{kJ/L (Propane)}}{\text{kJ/L (Gasoline)}}$$

$$\frac{\text{kJ/L (Grade 1 Propane)}}{\text{kJ/L (Indolene)}} = \frac{23580}{33020} = 0.71$$

$$\frac{\text{kJ/L (Grade 1 Propane)}}{\text{kJ/L (Gasoline)}} = \frac{23580}{31580} = 0.75$$

* Taylor, C.F., "Internal Combustion Engine in Theory and Practice", Vol. II, pg. 120, M.I.T. Press, Cambridge, Massachusettes, 1968

** Harvey, C.A., "Gasoline-Equivalent Fuel Economy Determination for Alternate Automotive Fuels", SAE Paper 820794, July 1982

\# CGSB Specification Can 2-3.14-M78 Equivalent to HD-5

APPENDIX F

May 21, 1982

TO FLEET OPERATORS:

SUBJECT: CHRYSLER CANADA LTD.'S LINE OF PROPANE FUELED-VEHICLES

Chrysler Canada Ltd. is now offering a broad selection of vehicles specifically engineered for operation on propane fuel:

- Vans and Wagons with 5.2 litre engine.
- Light Duty Sweptline Pickups with 5.2 litre engine and 8 foot box.
- Caravelle and Diplomat passenger cars with 5.2 litre or 3.7 litre engine.

These vehicles are built completely by Chrysler in Chrysler's own plants. They are designed specifically for propane, and have better power, fuel economy and driveability than can be expected with after-market conversions.

Now is an opportune time for you to consider the benefits of factory-equipped propane-fueled vehicles. In addition to the fuel cost savings (see attachment), the Federal Government offers purchasers of vehicles for commercial use a $400 taxable grant for each propane vehicle purchased. In Ontario, the 7% retail sales tax on the price of the propane vehicle is waived and this saving, when coupled with the federal grant, can in some cases cover the cost of the propane option before the fuel cost savings start.

The attached pages describe the engineering features of Chrysler Canada Ltd.'s line of propane vehicles and provides pertinent operating cost and warranty information.

We would also like to request your co-operation in completing the attached survey and then returning the survey to our Propane Development Co-ordinator in the enclosed stamped, pre-addressed envelope.

Please call one of the following Regional Truck and Fleet Sales Managers if you require more information:

Location	Name	Telephone
Toronto, Ontario	E. O. Prokopchuk	(416) 826-1040
Montreal, Quebec	R. P. Briand	(514) 697-4880
Moncton, New Brunswick	M. B. LeBlanc	(506) 382-3341
Winnipeg, Manitoba	D. P. Pambrun	(204) 633-4830
Red Deer, Alberta	K. P. Lefebvre	(403) 346-4151
Vancouver, B.C.	J. A. Lockhart	(604) 325-3211

We believe that you will discover that the Chrysler Canada Ltd. "Propane Option" is to your advantage.

Yours very truly,

CHRYSLER CANADA LTD.

G. Y. Landry
Vice-President and
General Sales Manager

/cm
attach.

CHRYSLER CANADA LTD.'S PROPANE OPTION - FLEET ADVANTAGES

FUEL COST SAVINGS

Propane is an excellent, clean-burning motor fuel with an assured Canadian supply. It is available across Canada through an expanding network of retail service stations. Also, fleets may take advantage of price discounts through bulk storage tanks located on their own premises. Its price varies markedly from province to province, but it enjoys a significant overall cost advantage compared to gasoline in most of the country. Although a litre of propane contains about 25% less energy than a litre of gasoline, Chrysler's factory-built propane vehicles make up for much of this difference through higher engine efficiency, particularly in city traffic operation.

Therefore, significant net fuel cost savings can be achieved in most areas of Canada. Estimated savings are shown below for an eight cylinder van/wagon.

Market Areas	Fuel Cost Diff. ¢/Litre	Total Fuel Cost Savings* At			
		30,000 km	60,000 km	90,000 km	120,000 km
Vancouver	21.5	$1,091	$2,182	$3,273	$4,364
Edmonton	16.7	836	1,672	2,508	3,344
Winnipeg	15.5	704	1,408	2,112	2,816
Toronto	17.2	804	1,608	2,412	3,216
Montreal	13.9	492	984	1,476	1,968

*Based on April 27, 1982 service station prices for propane and regular leaded gasoline and on urban fuel consumption ratings determined for each fuel using Transport Canada test procedures.

ENGINE FEATURES

- Ignition distributors have dual pickups which allow both optimum start timing and "high basic" run timing.
- Distributors have special centrifugal and vacuum advance curves tailored to propane, for best performance and fuel economy.
- No emission controls are needed, avoiding their effects on fuel consumption, driveability and maintenance.
- Intake manifold heating is removed to assure maximum charge density.
- Special top piston rings are installed for optimum engine break-in.
- High alloy exhaust valve seat inserts, together with controlled rotation exhaust valves, provide extra valve durability on the 5.2 litre truck engine. This improved engine is also used in all 5.2 litre passenger car applications.

(cont'd)

CARBURETION

Propane powered vehicles built by Chrysler Canada Ltd. use proven Impco carburetion equipment. No other propane fuel system manufacturer can match Impco's established market penetration and the resulting level of field familiarity with their equipment. Special modifications and unique Chrysler calibration of the Impco components provide superior fuel economy, driveability and acceleration. Additional features include:

- Automatic priming combined with a throttle-actuated override switch for optimum all-weather starting.
- Two-speed idle system compensates for cold engine friction and assures reliable idling under adverse conditions.
- High capacity vapourizer for reliable operation in cold weather.
- Fresh air duct system provides maximum engine power.

FUEL TANKS

Each of Chrysler Canada Ltd.'s fuel tank installations is unique to the particular model on which it is used. These installations have been custom designed to provide the best combination of tank capacity, ground clearance, and cargo space. In each case, the propane vehicle range is equal to, or greater than, the standard gasoline vehicle. Auxiliary tanks will be made available on vans and pick-ups to provide for those applications where extra range is a requirement.

The fuel tanks are equipped with integral mounting brackets which bolt directly to the vehicle structure for a strong, reliable installation. The fuel filler port is located in the normal (gasoline vehicle) location for easy access and is made tamper resistant by a locking type fuel filler door. The standard vehicle fuel gauge is used for fuel level indication.

WARRANTY AND SERVICE

Warranty coverage is the same as for gasoline fueled vehicles. Parts and service are available through our present dealer network.

CHRYSLER CANADA LTD.'S "PROPANE OPTION"

FLEET OPERATOR SURVEY

Please answer the following questions as indicated, and then return this survey form in the enclosed stamped and pre-addressed envelope. Your co-operation is appreciated in assisting us in further propane application development.

1. Do you currently operate propane-fueled vehicles: ☐ Yes ☐ No

2. If yes to Number "1", are these vehicles: ☐ Cars ☐ Vans ☐ Light Duty Pickups ☐ Other

3. Do you intend to purchase/lease factory propane-fueled vehicles in the near future? ☐ Yes ☐ No

4. If yes to Number "3", which of the following application(s) best meets your requirements. (Please place a check-mark in the appropriate box(es).

	ENGINE APPLICATION		
VEHICLE TYPE	4 CYL.	6 CYL.	8 CYL.
Vans		☐	☐
Wagons		☐	☐
Light Duty Pickups		☐	☐
Caravelle/Diplomat		☐	☐
Reliant/Aries Sedan	☐		
Reliant/Aries Wagon	☐		

ADDITIONAL COMMENTS:

_____

_____

_____

_____

FLEET NAME _____ FLEET CONTACT NAME _____

LOCATION _____

_____ SIGNATURE _____

_____ DATE _____